PATENT ABSTRACTS OF JAPAN

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(71)Applicant : IBIDEN CO LTD
(72)Inventor : KODAMA HIROAKI
ASAI MOTOO
TANAKA TOYOAKI

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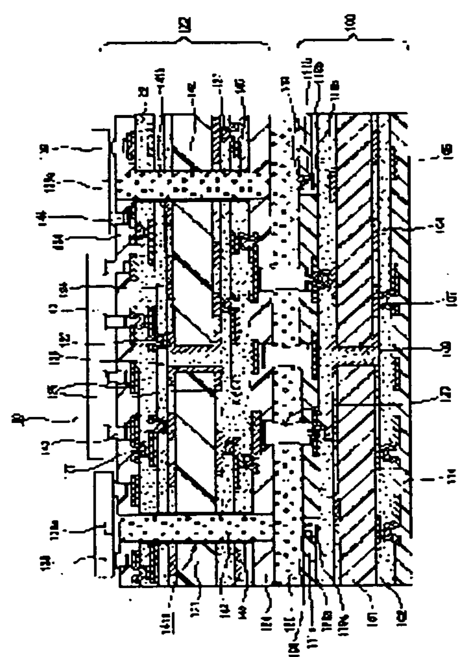
(54) DEVICE FOR OPTICAL COMMUNICATIONS AND ITS MANUFACTURING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a device for optical communications whose connection reliability is high by reducing connection loss between packaged optical parts and which is small-sized by integrating optical parts and electronic parts necessary for the optical communications by constituting the device of a printed board for packaging an IC chip where an optical device is packaged at a specified position and a multilayer printed wiring board where an optical waveguide is formed at a specified position.
SOLUTION: The device for the optical communications is constituted of the printed board for packaging the IC chip where an optical path for transmitting an optical signal is formed and also the optical device is packaged on one surface and the multilayer printed wiring board where at least the optical waveguide is formed, and the optical signal is transmitted by the optical waveguide and the optical device through the optical path for transmitting the optical signal.



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CLAIMS

[Claim(s)]
[Claim 1]
The substrate for IC chip mounting with which the optical element was mounted in the field of 1 while the optical path for lightwave signal transmission was formed,
It is the device for optical communication which consists of a multilayer printed wiring board with which optical waveguide was formed at least,
The device for optical communication characterized by being constituted so that said optical waveguide and said optical element can transmit a lightwave signal through said optical path for lightwave signal transmission.
[Claim 2]
The device for optical communication according to claim 1 with which the closure resin layer is formed between said substrates for IC chip mounting and said multilayer printed wiring boards.
[Claim 3]
Said closure resin layer is a device for optical communication according to claim 2 whose transmission of communication link wavelength light is 70% or more.
[Claim 4]
The device for optical communication according to claim 2 or 3 with which the particle is contained in said closure resin layer.
[Claim 5]
The device for optical communication given in any 1 [of said optical path for lightwave signal transmission] of claims 1-4 by which the micro lens is arranged at least in the edge by the side of a multilayer printed wiring board.
[Claim 6]
The device for optical communication given in any 1 of claims 2-4 with the refractive index of said micro lens a micro lens is arranged in the edge by the side of a multilayer printed wiring board at least, and larger [said closure resin layer] of said optical path for lightwave signal transmission than a refractive index.
[Claim 7]
Said optical element is a device for optical communication given in any 1 of claims 1-6 which are a photo detector and/or a light emitting device.
[Claim 8]
Said optical path for lightwave signal transmission is a device for optical communication given in any 1 of claims 1-7 by which the resin layer for optical paths is formed in the interior.
[Claim 9]
While the optical path for lightwave signal transmission is formed, after manufacturing separately the substrate for IC chip mounting with which the optical element was mounted in the field of 1, and the multilayer printed wiring board with which optical waveguide was formed at least,
Between the optical element of said substrate for IC chip mounting, and the optical waveguide of said multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it,
Furthermore, the manufacture approach of the device for optical communication characterized by forming a closure resin layer by performing hardening processing after slushing the resin constituent for the closures between said substrates for IC chip mounting and said multilayer printed wiring boards.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the manufacture approach of the device for optical communication, and the device for optical communication.
[0002]
In recent years, attentions have gathered for the optical fiber focusing on the communication link field. In especially IT (information technology) field, the communication technology which used the optical fiber for maintenance of the high-speed Internet network is needed.
An optical fiber **1 Low loss, **2 High bandwidth, **3 A narrow diameter and a light weight, **4 No guiding, **5 In the communication system using the optical fiber which has the descriptions, such as saving resources, and has these descriptions, compared with the communication system using the conventional metallic cable, the number of repeaters can be reduced sharply, construction and maintenance become easy, and economization of communication system and high-reliability-ization can be attained.
[0003]
Moreover, since an optical fiber can multiplex the light of the wavelength from which not only the light of one wavelength but many differ to coincidence with one optical fiber, it can realize the transmission line of the large capacity which can respond to various applications, and can respond to image service etc.
[0004]
Then, in network communication, such as such the Internet, using the optical communication using an optical fiber not only for the communication link of a backbone but for the communication link with a backbone and terminal equipments (a personal computer, mobile one, game, etc.) and the communication link of terminal equipments is proposed.
[0005]
Thus, when using optical communication for the communication link with a backbone and a terminal equipment etc., in order for IC which performs information (signal) processing in a terminal equipment to operate with an electrical signal, it is necessary to attach the equipment (henceforth light/electric transducer) which changes the lightwave signal and electrical signal of optical -> electric transducer, electric -> phototransducer, etc. into a terminal equipment. So, in the conventional terminal equipment, for example, optics, such as a package substrate which mounted IC chip, a photo detector which processes a lightwave signal, and a light emitting device, etc. were mounted separately, electric wiring and optical waveguide were connected to these, and a signal transmission and signal processing were performed.
[0006]
[Problem(s) to be Solved by the Invention]
In such a conventional terminal equipment, since IC mounting package substrate and the optic were mounted separately, the whole equipment became large and had become the factor which bars the miniaturization of a terminal equipment.
Moreover, in the conventional terminal equipment, since the distance of IC mounting package substrate and an optic was separated, electric wiring distance is long and it was easy to generate the signal error by a cross talk noise etc. at the time of a signal transmission.
[0007]
[Means for Solving the Problem]
Then, this invention persons completed the device for optical communication of this invention which consists that it can contribute to the miniaturization of a terminal equipment of a header and the following configuration while being able to attain the optical communication which is excellent in connection dependability by carrying

out opposite arrangement of the substrate for IC chip mounting and multilayer printed wiring board which mounted various optics as a result of inquiring wholeheartedly.
Furthermore, since the stress which the foreign matter which is floating the inside of air does not enter between each optic, in addition is generated between the substrate for IC chip mounting and a multilayer printed wiring board was able to be eased when a closure resin layer is formed in the device for optical communication between the substrates for IC chip mounting and multilayer printed wiring boards which carried out opposite arrangement, it found out becoming the device for optical communication which is more excellent in dependability.
[0008]
That is, the device for optical communication of this invention is the substrate for IC chip mounting with which the optical element was mounted in the field of 1 while the optical path for lightwave signal transmission was formed,
It is the device for optical communication which consists of a multilayer printed wiring board with which optical waveguide was formed at least,
It is characterized by being constituted so that the above-mentioned optical waveguide and the above-mentioned optical element can transmit a lightwave signal through the above-mentioned optical path for lightwave signal transmission.
[0009]
In the above-mentioned device for optical communication, it is desirable to form the closure resin layer between the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board, and, as for the above-mentioned closure resin layer, it is desirable for the permeability of communication link wavelength light to be 70% or more.
Furthermore, it is desirable to contain the particle in the above-mentioned closure resin layer.
[0010]
Moreover, the thing of the above-mentioned optical path for lightwave signal transmission for which the micro lens is arranged in the edge by the side of a multilayer printed wiring board at least in the above-mentioned device for optical communication is desirable. The micro lens is arranged in the edge by the side of a multilayer printed wiring board even if there are few above-mentioned optical paths for lightwave signal transmission. When the closure resin layer is formed between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, as for the refractive index of the above-mentioned micro lens, it is desirable that it is larger than the refractive index of the above-mentioned closure resin layer.
[0011]
As for the above-mentioned optical element, in the above-mentioned device for optical communication, it is desirable that they are a photo detector and/or a light emitting device.
Moreover, as for the above-mentioned optical path for lightwave signal transmission, it is desirable to form the resin layer for optical paths in the interior.
[0012]
After the manufacture approach of the device for optical communication of this invention manufactured separately the substrate for IC chip mounting with which the optical element was mounted in the field of 1, and the multilayer printed wiring board with which optical waveguide was formed at least while the optical path for lightwave signal transmission was formed,
Between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it,
Furthermore, after slushing the resin constituent for the closures between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, it is characterized by forming a closure resin layer by performing hardening processing.
[0013]
[Embodiment of the Invention]
Hereafter, the device for optical communication of this invention is explained.
The device for optical communication of this invention is the substrate for IC chip mounting with which the optical element was mounted in the field of 1 while the optical path for lightwave signal transmission was formed,

It is the device for optical communication which consists of a multilayer printed wiring board with which optical waveguide was formed at least,
It is characterized by being constituted so that the above-mentioned optical waveguide and the above-mentioned optical element can transmit a lightwave signal through the above-mentioned optical path for

lightwave signal transmission.
[0014]
Since the device for optical communication of this invention consists of a substrate for IC chip mounting with which the optical element was mounted in the position, and a multilayer printed wiring board with which optical waveguide was formed in the position, its connection loss between the mounted optics is low, and excellent in connection dependability as a device for optical communication.
Moreover, in the above-mentioned device for optical communication, since an optic and electronic parts required for optical communication can be unified, it can contribute to the miniaturization of the terminal equipment for optical communication.
[0015]
Moreover, in the device for optical communication of this invention, it is desirable to form the closure resin layer between the substrate for IC chip mounting and a multilayer printed wiring board. Since dust, a foreign matter, etc. which are floating the inside of air do not enter between an optical element and optical waveguide and transmission of a lightwave signal is not checked with this dust, foreign matter, etc. when the closure resin layer is formed, it will excel with the dependability as a device for optical communication.
[0016]
Furthermore, since the duty with which this closure resin layer eases the stress which originates in the difference of a coefficient of thermal expansion, and is generated between the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board can be achieved when the closure resin layer is formed, fracture near the solder bump which connects the substrate for IC chip mounting and a multilayer printed wiring board etc. can be prevented. Moreover, when the above-mentioned closure resin layer is formed, it is harder to generate location gap of an optical element and optical waveguide, and transmission of the lightwave signal between an optical element and optical waveguide is not checked, either.
Therefore, when the closure resin layer is formed between the substrate for IC chip mounting, and the multilayer printed wiring board also from such a point, it will excel with the dependability as a device for optical communication.
[0017]
Moreover, as for the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, in the device for optical communication of this invention, connecting electrically through a solder bump is desirable. It is because both can be more certainly stationed to a position according to the self-alignment operation which solder has.
In addition, it is thought that it happens in order that the surface tension which is going to become a globular form when solder is attached to a metal, while the operation which is going to exist in a stable configuration by near the center of opening for solder bump formation with the fluidity to which self has [solder] a self-alignment operation at the time of reflow processing is said and, as for this operation, solder is crawled by the solder resist layer may work strongly. Though location gap has occurred to both in front of a reflow in case the above-mentioned substrate for IC chip mounting is connected on the above-mentioned multilayer printed wiring board through the above-mentioned solder bump when this self-alignment operation is used, the above-mentioned substrate for IC chip mounting can move at the time of a reflow, and this substrate for IC chip mounting can be attached in the exact location on the above-mentioned multilayer printed wiring board. therefore, if it is alike, respectively and optics, such as a photo detector, a light emitting device, and optical waveguide, are attached in the exact location, the device for optical communication which is excellent in connection dependability can be manufactured by [of the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board] connecting the above-mentioned substrate for IC chip mounting on the above-mentioned multilayer printed wiring board through a solder bump.
[0018]
Hereafter, the device for optical communication of this invention is explained, referring to a drawing.
Drawing 1 is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention. In addition, the device for optical communication in the condition that IC chip was mounted is shown in drawing 1 R> 1.
[0019]
As shown in drawing 1 , the device 150 for optical communication consists of the substrates 120 for IC chip mounting and multilayer printed wiring boards 100 which mounted the IC chip 140, and the substrate 120 for IC chip mounting and the multilayer printed wiring board 100 are electrically connected through the solder connection 137.
Moreover, the closure resin layer 160 is formed between the substrate 120 for IC chip mounting, and the multilayer printed wiring board 100.

[0020]
the substrate 120 for IC chip mounting — both sides of a substrate 121 — a conductor — the conductor with which laminating formation was carried out and the substrate 121 of the resin insulating layer [circuits 124 and 125 and] 122 between layers was pinched — the conductor which sandwiched circuits and the resin insulating layer 122 between layers — circuits are electrically connected by the through hole 129 and the Bahia hall 127, respectively. Moreover, the solder resist layer 134 is formed in the outermost layer.
this substrate 120 for IC chip mounting — both sides — a conductor — the optical path 141 (141a, 141b) for lightwave signal transmission which penetrates the substrate 121 with which circuits 124 and 125, the resin insulating layer 122 between layers, and the solder resist layer 134 were formed is formed, a conductor layer 145 is formed in that wall surface, and, as for the optical path 141 for lightwave signal transmission, the resin layer 142 for optical paths is formed in that interior.
In addition, the above-mentioned conductor layer does not need to be formed.
[0021]
Furthermore, while the surface mount of a photo detector 138 and the light emitting device 139 is carried out through the solder connection 144 so that each of light sensing portion 138a and light-emitting part 139a may counter the optical path 141 for lightwave signal transmission, the surface mount of the IC chip 140 is carried out to the field of 1 of the substrate 120 for IC chip mounting through the solder connection 143.
[0022]
a multilayer printed wiring board 100 — both sides of a substrate 101 — a conductor — the conductor with which laminating formation was carried out and the substrate 101 of the resin insulating layer [a circuit 104 and] 102 between layers was pinched — the conductor which sandwiched circuits and the resin insulating layer 102 between layers — circuits are electrically connected by the through hole 109 and the Bahia hall 107, respectively.
moreover, in the mounting substrate 120 for IC chip of a multilayer printed wiring board 100, and the outermost layer of the side which counters While the solder resist layer 114 equipped with the opening 111 for optical paths and a solder bump is formed The optical waveguide 118 (118a, 118b) equipped with the optical-path conversion mirror 119 (119a, 119b) is formed directly under [for optical paths] opening 111 (111a, 111b), and the resin layer 108 for optical paths is formed in the opening 111 for optical paths.
[0023]
In the device 150 for optical communication which consists of such a configuration the lightwave signal sent from the outside through an optical fiber (not shown) etc. introduces into optical waveguide 118a — having — optical-path conversion mirror 119a and opening 111for optical paths a — further after being sent to a photo detector 138 (light sensing portion 138a) through the closure resin layer 160 and optical-path 141a for lightwave signal transmission, it changes into an electrical signal by the photo detector 138 — having — further — a conductor — it will be sent to the IC chip 140 through a circuit and a solder connection.
[0024]
Moreover, the electrical signal sent out from the IC chip 140 After being sent to a light emitting device 139 through a circuit, it is changed into a lightwave signal by the light emitting device 139. a solder connection and a conductor — This lightwave signal Optical-path from light emitting device 139 (light-emitting part 139a) 141for lightwave signal transmission b, the closure resin layer 160 and opening 111for optical paths b — and it optical-path conversion mirror 119b minds, is introduced into optical waveguide 118b, and is delivery outside as a lightwave signal through an optical fiber (not shown) etc. further — it will be carried out.
[0025]
In such a device for optical communication of this invention, since an optic and electronic parts required for optical communication can be unified while the transmission distance of an electrical signal is short and can respond to a high-speed communication link more in the location near the inside of the substrate for IC chip mounting, i.e., IC chip, since light / electrical signal conversion is performed, it can contribute to the miniaturization of the terminal equipment for optical communication.
[0026]
moreover, at the above-mentioned device for optical communication, the electrical signal sent out from IC chip is delivery outside through an optical fiber, after being changed into a lightwave signal, as mentioned above — it is not only carried out, but it sends to a multilayer printed wiring board through a solder bump — having — the conductor of this multilayer printed wiring board — it will be sent to electronic parts, such as other IC chips mounted in the multilayer printed wiring board, through a circuit (the Bahia hall and a through hole are included).
[0027]
Moreover, in the device 150 for optical communication shown in drawing 1 , the closure resin layer 160 is formed between the substrate 120 for IC chip mounting, and the multilayer printed wiring board 100. Thus, since dust, a

foreign matter, etc. which are floating the inside of air do not enter between an optical element and optical waveguide and transmission of a lightwave signal is not checked by existence of dust or a foreign matter, the device for optical communication with which the closure resin layer is formed between the substrate for IC chip mounting and the multilayer printed wiring board will be more excellent in dependability.
[0028]
As the above-mentioned closure resin layer, especially if there is little absorption by the communication link wavelength range, it will not be limited, but as the ingredient, thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was sensitization-ized, ultraviolet curing mold resin, etc. are mentioned, for example. In these, thermosetting resin is desirable.
Specifically, the polymer manufactured from silicone resin; benz-cyclo-butene, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, is mentioned.
[0029]
Moreover, as for the above-mentioned closure resin layer, it is desirable for the permeability of communication link wavelength light to be 70% or more.
At less than 70%, the transmission of communication link wavelength light has large loss of a lightwave signal, and is because it may lead to the fall of the dependability of the device for optical communication. As for the above-mentioned permeability, it is more desirable that it is 90% or more.
When consisting only of a resinous principle which the above-mentioned closure resin layer mentioned above especially, as for the permeability, it is desirable that it is 90% or more, and when the particle is blended with the closure resin layer so that it may mention later, as for the permeability, it is desirable that it is 70% or more.
[0030]
In addition, in this specification, the permeability of communication link wavelength light means the permeability of the communication link wavelength light per die length of 1mm. When the light of I1 carried out incidence to the above-mentioned closure resin layer in strength, passing this closure resin layer 1mm, and having come out, and the intensity of light which came out is I2, it is specifically the value computed by the following formula (1).
[0031]
Permeability (%) $=(I2/I1) \times 100$ ... (1)
[0032]
In addition, the above-mentioned permeability means the permeability measured at 25-30 degrees C.
[0033]
Moreover, it is desirable to contain particles, such as a resin particle, an inorganic particle, and metal particles, in the above-mentioned closure resin layer.
By including a particle, it is because it is harder coming to generate the crack which could be made to adjust a coefficient of thermal expansion between the above-mentioned substrate for IC chip mounting, or the above-mentioned multilayer printed wiring board, and originated in the difference of a coefficient of thermal expansion.
[0034]
In the device for optical communication of this invention which consists of a substrate for IC chip mounting, and a multilayer printed wiring board in addition, the coefficient of thermal expansion (the direction of the z-axis) of the configuration member A substrate For example, 5.0x10-5 - 6.0x10-5 (/degree C) extent, The resin insulating layer between layers 6.0x10-5 - 8.0x10-5 (/degree C) extent, 0.1x10-5 - 1.0x10-5 (/degree C) extent and a closure resin layer 0.1x10-5 - 100x10-5 (/degree C) extent, [a particle] The closure resin layer with which the particle was blended 3.0x10-5 - 4.0x10-5 (/degree C) extent, an optical element made from IC chip, silicon, germanium, etc. — 0.5x10-5 - 1.5x10-5 (/degree C) extent and a conductor — a circuit is 1.0x10-5 - 2.0x10-5 (/degree C) extent. In addition, the measurement temperature of the above-mentioned coefficient of thermal expansion is 20 degrees C.
Thus, if the particle is blended with the closure resin layer, the difference of the coefficient of thermal expansion of this closure resin layer and other configuration members which constitute the device for optical communication will become small. Therefore, stress will be eased.
Moreover, when the particle is blended with the closure resin layer, it is harder coming to generate location gap of an optical element and optical waveguide.
[0035]
Moreover, when blending a particle with the above-mentioned closure resin layer, the comparable thing of the refractive index of the resinous principle of this closure resin layer and the refractive index of the above-mentioned particle is desirable. Therefore, when blending a particle with a closure resin layer, it is desirable to mix two or more kinds of particles from which a refractive index differs, and to make it the refractive index of a particle become comparable as the refractive index of a resinous principle.

When a resinous principle is the epoxy resin of a refractive index 1.53, specifically, it is desirable for the silica particle and refractive index of 1.54 to mix the titania particle of 1.52, and for a refractive index to use.
In addition, after melting and mixing the approach and two or more kinds of particles to knead as an approach of mixing a particle, the approach of making it into the shape of a particle etc. is mentioned.
[0036]
What consists of resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was photosensitivity-ized, thermosetting resin, and thermoplastics, complex of a photopolymer and thermoplastics, etc. as the above-mentioned resin particle, for example is mentioned.
[0037]
Specifically For example, an epoxy resin, phenol resin, polyimide resin, Thermosetting resin, such as a bismaleimide resin, polyphenylene resin, polyolefin resin, and a fluororesin; The heat-curing radical of these thermosetting resin A methacrylic acid, an acrylic acid, etc. are made to react to (for example, the epoxy group in an epoxy resin). Resin which gave the acrylic radical; Phenoxy resin, polyether sulfone (PES), Thermoplastics, such as polysulfone (PSF), a polyphenylene sulfone (PPS), polyphenylene sulfide (PPES), a polyphenyl ether (PPE), and polyether imide (PI); what consists of photopolymers, such as acrylic resin, etc. is mentioned.
Moreover, what consists of resin complex of the resin complex of the above-mentioned thermosetting resin and the above-mentioned thermoplastics, the resin which gave the above-mentioned acrylic radical, the above-mentioned photopolymer, and the above-mentioned thermoplastics can also be used.
Moreover, the resin particle which consists of rubber can also be used as the above-mentioned resin particle.
[0038]
Moreover, as the above-mentioned inorganic particle, what consists of titanium compounds, such as silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, and basic magnesium carbonate, a silica, and a zeolite, and a titania, etc. is mentioned, for example. Moreover, what was made to mix and carry out melting of a silica and the titania at a fixed rate, and was equalized may be used.
Moreover, what consists of Lynn or phosphorus compounds can also be used as the above-mentioned inorganic particle.
[0039]
As the above-mentioned metal particles, what consists of gold, silver, copper, palladium, nickel, platinum, iron, zinc, lead, aluminum, magnesium, calcium, etc. is mentioned, for example.
These resin particles, an inorganic particle, and metal particles may be used independently, and may be used together two or more sorts.
[0040]
Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of a globular shape or an ellipse ball is desirable. It is because there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, so it is harder to generate a crack etc. in a closure resin layer. furthermore, that the configuration of the above-mentioned particle is spherical or an ellipse — when spherical, it will be hard to reflect light by this particle, and loss of a lightwave signal will be reduced.
[0041]
Moreover, the minimum with a desirable particle size of the above-mentioned particle is 0.01 micrometers, and a more desirable minimum is 0.1 micrometers. On the other hand, the upper limit with the above-mentioned desirable particle size is 100 micrometers, a more desirable upper limit is 50 micrometers, and, as for especially the upper limit, it is desirable that it is shorter than communication link wavelength. It is because a possibility that transmission of a lightwave signal may be checked more will decrease if the mean particle diameter of the above-mentioned particle is shorter than communication link wavelength.
Moreover, as long as it is the particle which has the particle size of this range, the particle of two or more kinds of different particle size may be included.
In addition, in this specification, the particle size of a particle means the die length of the longest part of a particle.
[0042]
The minimum with the desirable loadings of the particle contained in the above-mentioned closure resin layer is 10 % of the weight, and a more desirable minimum is 20 % of the weight. On the other hand, the upper limit with the desirable loadings of the above-mentioned particle is 80 % of the weight, and a more desirable upper limit is 70 % of the weight. It is because transmission of a lightwave signal may be checked when the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight may not be

acquired and the loadings of a particle exceed 80 % of the weight.
In addition, what is necessary is just to choose the concrete presentation suitably so that a closure resin layer may fill the low loss nature of a lightwave signal, and the outstanding thermal resistance and crack-proof nature in order that the presentation of the above-mentioned closure resin layer may affect dependability, such as transmission loss of a lightwave signal, thermal resistance, and flexural strength.
[0043]
In the device for optical communication of this invention, it is desirable for the refractive index of the above-mentioned optical path for lightwave signal transmission and the refractive index of the above-mentioned closure resin layer to be the same. for example, when the refractive index of the above-mentioned optical path for lightwave signal transmission is smaller than the refractive index of the above-mentioned closure resin layer The lightwave signal which the lightwave signal transmitted through the optical path for lightwave signal transmission will condense toward the light sensing portion of a photo detector, and was sent out from the above-mentioned light emitting device It will originate in both refractive indexes of what will be refracted in the direction which does not spread in the interface of the optical path for lightwave signal transmission and a closure resin layer differing, and reflection of a lightwave signal will occur in the interface of the optical path for lightwave signal transmission, and a closure resin layer, consequently the transmission loss of a lightwave signal becomes large. Therefore, in order to make transmission loss of a lightwave signal small, it will be desirable for the refractive index of the optical path for lightwave signal transmission and the refractive index of the above-mentioned closure resin layer to be the same, and it will usually choose both refractive index suitably in consideration of the degree of reflection of the lightwave signal in the interface of the optical path for lightwave signal transmission, and a closure resin layer, and the degree of refraction.
[0044]
In addition, the refractive index of the resinous principle used for the above-mentioned closure resin layer etc. 1.50 to about 1.60 and acrylic resin 1.40 to about [for example,] 1.55 [an epoxy resin] As an approach of polyolefine being 1.55 to about 1.65 and adjusting refractive indexes, such as the above-mentioned closure resin layer For example, by fluorinating a part of resinous principle, or phenyl-izing, by changing polarizability or deuterating a part of resinous principle, molecular weight is changed and the method of changing the refractive index of a resinous principle etc. is mentioned. In addition, such an adjustment approach of a refractive index can be used also as an approach of adjusting the refractive index of optical waveguide.
[0045]
In the above-mentioned device for optical communication, as shown in drawing 1 , as for the optical path for lightwave signal transmission, it is desirable to form the resin layer for optical paths in the interior. Although it is desirable to form the closure resin layer between the substrate for IC chip mounting and a multilayer printed wiring board in the device for optical communication of this invention as mentioned above When the interior of the optical path for lightwave signal transmission is constituted by the opening, in case a closure resin layer is formed, it is because a closure resin layer may enter into the part within this optical path for lightwave signal transmission and transmission of a lightwave signal may be checked by this.
[0046]
Moreover, as the above-mentioned device for optical communication shows to drawing 1 , it is desirable to form the conductor layer in the wall surface of the optical path for lightwave signal transmission. By forming a conductor layer in the wall surface of the optical path for lightwave signal transmission, it is because the scattered reflection of the light in the wall surface of the above-mentioned optical path for lightwave signal transmission can be reduced and the transmission nature of a lightwave signal can be raised.
[0047]
Moreover, it is desirable to form the resin layer for optical paths in the above-mentioned device for optical communication also in opening for optical paths prepared in the multilayer printed wiring board, and it is desirable for the refractive index of the above-mentioned resin layer for optical paths and the refractive index of a closure resin layer to be the same in this case. When both refractive index is the same, it is because transmission loss of a lightwave signal can be made small like the case where the refractive index of the optical path for lightwave signal transmission and the refractive index of a closure resin layer are the same.
furthermore, when the inside of the above-mentioned opening for optical paths is an opening In the process which forms the closure resin layer at the time of the above-mentioned device manufacture for optical communication Although the resin constituent which is not hardened for forming a closure resin layer may enter in the opening of the above-mentioned opening for optical paths, a void may occur in that case and generating of such a void may have a bad influence on the lightwave signal transmission ability of the device for optical communication When the resin layer for optical paths is formed in opening for optical paths, such a problem does not occur.

[0048]
Moreover, while a closure resin layer is formed between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board and the resin layer for optical paths is further formed in the interior of the above-mentioned optical path for lightwave signal transmission When the resin layer for optical paths is formed also in the interior of the above-mentioned opening for optical paths, the same thing of each refractive index of the resin layer for optical paths in the above-mentioned closure resin layer, the above-mentioned optical path for lightwave signal transmission, and the above-mentioned opening for optical paths is desirable. Thus, when three persons' refractive index is the same, it is because reflection of a lightwave signal does not take place by the interface of the above-mentioned closure resin layer and the above-mentioned resin layer for optical paths.

[0049]
Moreover, in the above-mentioned device for optical communication, the thing of the above-mentioned optical path for lightwave signal transmission for which the micro lens is arranged in the edge of one side at least is desirable.

Drawing 2 is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.

In the device 250 for optical communication shown in drawing 2 , like the device 150 for optical communication shown in drawing 1 , it consists of a substrate 220 for IC chip mounting, and a multilayer printed wiring board 200, and the closure resin layer 260 is formed between the substrate 220 for IC chip mounting, and the multilayer printed wiring board 200.

Moreover, the micro lens 246 is arranged in the edge by the side of the multilayer printed wiring board 200 of the optical path 241 for lightwave signal transmission with which the resin layer 242 for optical paths was formed in the interior in the substrate 220 for IC chip mounting.

Thus, a lightwave signal can be more certainly transmitted by arranging a micro lens between an optical element (a photo detector and light emitting device) and optical waveguide.

[0050]
In addition, the operation gestalt of the device 250 for optical communication is the same as the operation gestalt of the device 150 for optical communication, except that the micro lens 246 is arranged by the end of the optical path 242 for lightwave signal transmission of the substrate 220 for IC chip mounting.

[0051]
Moreover, as for the refractive index of the micro lens arranged by the end (multilayer printed wiring board side) of the above-mentioned optical path for lightwave signal transmission, it is desirable that it is larger than the refractive index of the above-mentioned closure resin layer. Since a lightwave signal can be made to condense towards desired by arranging the micro lens which has such a refractive index, transmission of a lightwave signal can be ensured.

[0052]
Moreover, when the above-mentioned micro lens is a convex configuration lens which has a convex only on one side (closure resin layer side) as shown in drawing 2 , the radius of curvature of the above-mentioned micro lens is suitably chosen in consideration of the focal distance of the above-mentioned micro lens. In specifically making radius of curvature small when lengthening the focal distance of a micro lens, and shortening a focal distance, it enlarges radius of curvature.

[0053]
Moreover, when the above-mentioned micro lens is arranged and the resin layer for optical paths is formed in the interior of the above-mentioned optical path for lightwave signal transmission, the refractive index of the above-mentioned micro lens may be larger than the refractive index of the above-mentioned resin layer for optical paths, and may be the same as the refractive index of the above-mentioned resin layer for optical paths.

[0054]
Moreover, although illustration has not been carried out, when the resin layer for optical paths is formed also in the interior of opening for optical paths of a multilayer printed wiring board, it is desirable to arrange the micro lens also in the edge by the side of the closure resin layer of this opening for optical paths, and it is desirable for the refractive index of a micro lens to be larger than the refractive index of the above-mentioned closure resin layer in this case.

[0055]
Moreover, opening for optical paths by which the micro lens is arranged also in the edge of opening for optical paths, and the resin layer for optical paths was formed in the interior, thickness with the optical path for lightwave signal transmission by which the resin layer for optical paths was formed in the interior — abbreviation — the refractive index of the micro lens arranged in the edge of opening for optical paths when the same, and

the refractive index of the micro lens arranged in the edge of the optical path for lightwave signal transmission -- abbreviation — the same thing is desirable.
Since the optical path for lightwave signal transmission can be condensed towards desired by arranging the micro lens which has such a refractive index, transmission of a lightwave signal can be ensured.
[0056]
It is not limited especially as the above-mentioned micro lens, but what is used for the optical lens is mentioned, and optical glass, the resin for optical lenses, etc. are mentioned as an example of the quality of the material.
As the above-mentioned resin for optical lenses, the polymer manufactured from silicone resin; benz-cyclo-butene, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, is mentioned, for example.
[0057]
That what is necessary is just to arrange in the edge of the optical path for lightwave signal transmission through a transparent adhesives layer when arranging a micro lens in the edge of the above-mentioned optical path for lightwave signal transmission, when the resin layer for optical paths is formed in the interior of the optical path for lightwave signal transmission, it may be directly arranged by this resin layer for optical paths.
In addition, that what is necessary is just to arrange in the edge of opening for optical paths through a transparent adhesives layer similarly when arranging a micro lens in the edge of opening for optical paths, when the resin layer for optical paths is formed in the interior of opening for optical paths, it may be directly arranged by this resin layer for optical paths.
[0058]
Although the installation location of the above-mentioned micro lens has a desirable edge by the side of the closure resin layer of the optical path for lightwave signal transmission formed in the substrate for IC chip mounting (a multilayer printed wiring board and side which counters), it is not necessarily limited here, may be attached in the edge by the side of the optical element of the optical path for lightwave signal transmission, and may be attached in the both ends of the optical path for lightwave signal transmission.
The configuration of the above-mentioned micro lens is not necessarily limited to the lens of a convex configuration as shown in drawing 2 , and is just condensed towards a request of a lightwave signal.
[0059]
Next, other configuration members of the device for optical communication of this invention etc. are explained.
The optical element (a photo detector, light emitting device) is mounted in the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
As the above-mentioned photo detector, PD (photodiode), APD (avalanche photodiode), etc. are mentioned, for example.
What is necessary is just to use these properly suitably in consideration of the configuration of the above-mentioned device for optical communication, demand characteristics, etc.
Si, germanium, InGaAs, etc. are mentioned as an ingredient of the above-mentioned photo detector.
In these, a point to InGaAs which is excellent in light-receiving sensibility is desirable.
[0060]
As the above-mentioned light emitting device, LD (semiconductor laser), DFB-LD (distribution feedback mold-semiconductor laser), LED (light emitting diode), etc. are mentioned, for example.
What is necessary is just to use these properly suitably in consideration of a configuration, demand characteristics, etc. of the above-mentioned device for optical communication.
[0061]
As an ingredient of the above-mentioned light emitting device, a gallium, arsenic and the compound (GaAsP) of Lynn, a gallium, aluminum and the compound (GaAlAs) of arsenic, a gallium and the compound (GaAs) of arsenic, an indium, a gallium and the compound (InGaAs) of arsenic, an indium, a gallium, arsenic, the compound (InGaAsP) of Lynn, etc. are mentioned.
That what is necessary is just to use these properly in consideration of communication link wavelength, when communication link wavelength is 0.85-micrometer band, GaAlAs can be used, and in the case of 1.3-micrometer band or 1.55-micrometer band, communication link wavelength can use InGaAs and InGaAsP.
In addition, as for the optical element mounted in the substrate for IC chip mounting, the resin seal of the perimeter may be carried out. Moreover, the resin seal of between an optical element, and the solder resist layers and the resin layers for optical paths by which mounting was carried out [above-mentioned] may be carried out, and the resin seal should just be performed in this case using the ingredient of for example, a closure resin layer, and the same ingredient.
[0062]

Moreover, the optical path for lightwave signal transmission is formed in the substrate for IC chip mounting which constitutes the device for optical communication of this invention, and a lightwave signal can be transmitted to it through the above-mentioned optical path for lightwave signal transmission between the optical element mounted in the above-mentioned substrate for IC chip mounting, and the optical waveguide formed in the above-mentioned multilayer printed wiring board.

[0063]

As for the above-mentioned optical path for lightwave signal transmission, it is desirable to form the resin layer for optical paths in the interior. Thus, it is because a possibility that it may be suitable for forming a closure resin layer, and dust, a foreign matter, etc. may enter between an optical element and optical waveguide decreases more as it mentioned above that the resin layer for optical paths was formed.

Furthermore, when the resin layer for optical paths is formed in the interior of the above-mentioned optical path for lightwave signal transmission, the reinforcement of the substrate for IC chip mounting is also excellent.

In addition, depending on the case, internal some or internal all of the above-mentioned optical path for lightwave signal transmission may be constituted by the opening.

[0064]

Moreover, when the resin layer for optical paths is formed in the interior of the optical path for lightwave signal transmission, especially if the resinous principle has little absorption by the communication link wavelength range, it will not be limited, but the same thing as the resin used for the above-mentioned closure resin layer etc. is mentioned as an example, for example.

Moreover, particles, such as a resin particle, an inorganic particle, and metal particles, may be contained in the above-mentioned resin layer for optical paths in addition to the above-mentioned resinous principle. Adjustment of a coefficient of thermal expansion can be aimed at by including these particles between the optical path for lightwave signal transmission, a substrate, the resin insulating layer between layers, a solder resist layer, etc. The thing same as an example of the above-mentioned particle as the particle contained in the above-mentioned closure resin layer etc. is mentioned.

[0065]

Moreover, especially the configuration of the above-mentioned optical path for lightwave signal transmission is not limited, for example, the shape of the shape of cylindrical and an elliptic cylinder and the square pole, many prismatic forms, etc. are mentioned. In these, the shape of a cylinder is desirable. It is because the formation is easy.

[0066]

Moreover, the desirable minimum of the path of the cross section of the above-mentioned optical path for lightwave signal transmission is 100 micrometers. While there is a possibility that an optical path may be closed for the path of the above-mentioned cross section by less than 100 micrometers, it is because it may become difficult to form the resin layer for optical paths in the interior of this optical path for lightwave signal transmission. On the other hand, the desirable upper limit of the path of the above-mentioned cross section is 500 micrometers. the conductor which whose transmission nature of a lightwave signal seldom improves even if it makes it larger than 500 micrometers, but is formed in the substrate for IC chip mounting — it is because it may become the cause which checks the degree of freedom of a design of a circuit.

While both the paths of the above-mentioned cross section are more excellent in the transmission nature of a lightwave signal, and the degree of freedom of a design, also in case it is filled up with a non-hardened resin constituent, from the point that un-arranging does not occur, the more desirable minimum is 250 micrometers and a more desirable upper limit is 350 micrometers. In addition, in the case of the shape of the diameter of the cross section, and an elliptic cylinder, in the case of the shape of the shape of the major axis of the cross section, and the square pole, or a multiple column, the path of the cross section of the above-mentioned optical path for lightwave signal transmission means the die length of the longest part of the cross section, when the above-mentioned optical path for lightwave signal transmission is a cylinder-like.

[0067]

As for the above-mentioned optical path for lightwave signal transmission, it is desirable to form the conductor layer in the wall surface, and the above-mentioned conductor layer may consist of one layer, and may consist of more than two-layer.

As an ingredient of the above-mentioned conductor layer, copper, nickel, chromium, titanium, noble metals, etc. are mentioned, for example.

moreover, the conductor with which the above-mentioned conductor layer sandwiched the duty as a through hole, i.e., a substrate, depending on the case — the conductor which sandwiched between circuits, and a substrate and the resin insulating layer between layers — the duty which connects between circuits electrically can be achieved.

Moreover, the ingredient of the above-mentioned conductor layer may be a metal which has gloss, such as gold, silver, nickel, platinum, aluminum, and a rhodium. In the conductor layer formed using the metal which has such gloss, a lightwave signal will reflect suitably.
[0068]
Moreover, the enveloping layer and roughening layer which consist of tin, titanium, zinc, etc. may be further prepared on the above-mentioned conductor layer. By preparing the above-mentioned enveloping layer and a roughening layer, adhesion of the optical path for lightwave signal transmission and the resin layer for optical paths can be raised.
[0069]
Moreover, when the conductor layer and the resin layer for optical paths are formed in the interior of the above-mentioned optical path for lightwave signal transmission, these may be in contact with the substrate or the resin insulating layer between layers through the roughening side. It is because it excels in adhesion with a substrate or the resin insulating layer between layers and is harder coming to generate exfoliation of a conductor layer etc., when the above-mentioned conductor layer has touched through the roughening side.
[0070]
Moreover, optical waveguide is formed in the multilayer printed wiring board which constitutes the device for optical communication of this invention.
The inorganic system optical waveguide which consists of the organic system optical waveguide and quartz glass which consist of a polymer ingredient etc., a compound semiconductor, etc. as the above-mentioned optical waveguide, for example is mentioned. In these, the organic system optical waveguide which consists of a polymer ingredient etc. is desirable. It is because it excels in adhesion with the resin insulating layer between layers and processing is easy.
[0071]
The complex of the resin and thermosetting resin with which it was not limited as the above-mentioned polymer ingredient especially when there was little absorption by the communication link wavelength range, for example, some of thermosetting resin, thermoplastics, photopolymers, and thermosetting resin were photosensitivity-ized, and thermoplastics, the complex of a photopolymer and thermoplastics, etc. are mentioned.
[0072]
Specifically, silicone resin, such as polyimide resin, such as acrylic resin, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, and fluorination polyimide, an epoxy resin, UV hardenability epoxy resin, polyolefine system resin, and deuteration silicone resin, the polymer manufactured from benz-cyclo-butene are mentioned.
[0073]
Particles, such as for example, a resin particle, an inorganic particle, and metal particles, may be contained in the above-mentioned optical waveguide in addition to the above-mentioned resinous principle.
The thing same as an example of the above-mentioned particle as the particle contained in the above-mentioned closure resin layer etc. is mentioned.
[0074]
Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of a globular shape or an ellipse ball is desirable. It is because there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, so it is harder to generate a crack etc. in optical waveguide. furthermore, that the configuration of the above-mentioned particle is spherical or an ellipse — when spherical, it will be hard to reflect light by the above-mentioned particle, and loss of a lightwave signal will be reduced.
[0075]
Moreover, the minimum with a desirable particle size of the above-mentioned particle is 0.01 micrometers, and a more desirable minimum is 0.1 micrometers. On the other hand, the upper limit with the above-mentioned desirable particle size is 100 micrometers, a more desirable upper limit is 50 micrometers, and, as for especially the upper limit, it is desirable that it is shorter than communication link wavelength. It is because a possibility that transmission of a lightwave signal may be checked more will decrease if the mean particle diameter of the above-mentioned particle is shorter than communication link wavelength.
Moreover, as long as it is the particle which has the particle size of this range, the particle of two or more kinds of different particle size may be contained.
[0076]
The minimum with the desirable loadings of the particle contained in the above-mentioned optical waveguide is 10 % of the weight, and a more desirable minimum is 20 % of the weight. On the other hand, the upper limit with the desirable loadings of the above-mentioned particle is 80 % of the weight, and a more desirable upper limit is

70 % of the weight. It is because transmission of a lightwave signal may be checked when the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight may not be acquired and the loadings of a particle exceed 80 % of the weight.
Moreover, although especially the configuration of the above-mentioned optical waveguide is not limited, since the formation is easy, the shape of a sheet is desirable.
[0077]
Thus, when a particle is contained in optical waveguide, adjustment of a coefficient of thermal expansion can be aimed at between optical waveguide, the substrate which constitutes a multilayer printed wiring board, the resin insulating layer between layers, etc., and it is harder coming to generate a crack, exfoliation, etc. resulting from the difference of a coefficient of thermal expansion.
[0078]
Moreover, the thickness of the above-mentioned optical waveguide has desirable 1-100 micrometers, and the width of face has desirable 1-100 micrometers. the conductor which constitutes a multilayer printed wiring board if the above-mentioned width of face is not sometimes easy for the formation in less than 1 micrometer and the above-mentioned width of face exceeds 100 micrometers on the other hand — it may become the cause which checks the degree of freedom of designs, such as a circuit
[0079]
Moreover, the ratio of the thickness of the above-mentioned optical waveguide and width of face has a desirable way near 1:1. This is usually because the flat-surface configuration of the light sensing portion of the above-mentioned photo detector or the light-emitting part of the above-mentioned light emitting device is a circle configuration. In addition, especially the ratio of the above-mentioned thickness and width of face is not limited, and should just usually be about 1:2 - about 2:1 abbreviation.
Furthermore, when the above-mentioned optical waveguide is the optical waveguide of the single mode which is the communication link wavelength of 1.55 micrometers, as for the thickness and width of face, it is desirable that it is 5-15 micrometers, and when the above-mentioned optical waveguide is the optical waveguide of a multimode on the communication link wavelength of 0.85 micrometers, it is desirable [the thickness and width of face] that it is 20-80 micrometers.
[0080]
Moreover, as the above-mentioned optical waveguide, it is desirable to form the optical waveguide for light-receiving and the optical waveguide for luminescence. In addition, the above-mentioned optical waveguide for light-receiving means the optical waveguide for transmitting the lightwave signal sent from the outside through an optical fiber etc. to a photo detector, and the above-mentioned optical waveguide for luminescence means the optical waveguide for transmitting the lightwave signal sent from the light emitting device to an optical fiber etc.
Moreover, it is desirable for the above-mentioned optical waveguide for light-receiving and the above-mentioned optical waveguide for luminescence to be what consists of the same ingredient. It is because adjustment of a coefficient of thermal expansion etc. is easy for a scale or the formation to like.
[0081]
It is desirable to form the optical-path conversion mirror in the above-mentioned optical waveguide, as mentioned above. By forming an optical-path conversion mirror, it is because it is possible to change an optical path into a desired include angle.
Formation of the above-mentioned optical-path conversion mirror can be performed by cutting the end of optical waveguide so that it may mention later.
[0082]
In addition, in drawing 1 and the multilayer printed wiring board shown in 2, although optical waveguide is formed on the resin insulating layer between layers of the substrate for IC chip mounting, and the outermost layer of the side which counters, the formation location of the optical waveguide in the device for optical communication of this invention may not necessarily be limited here, may be between the resin insulating layers between layers, and may be between a substrate and the resin insulating layer between layers. Furthermore, you may be between the resin insulating-layer top between layers of the outermost layer of the opposite side whose substrate was pinched the substrate for IC chip mounting, and the side which counters, and between the resin insulating layers between layers, a substrate, and the resin insulating layers between layers etc.
[0083]
That is, optical waveguide may be formed like the device for optical communication shown in drawing 14 on the resin insulating layer between layers of the outermost layer of the opposite side whose substrate was pinched the substrate for IC chip mounting of a multilayer printed wiring board, and the side which counters.
Drawing 14 is the sectional view showing typically 1 operation gestalt of the device for optical communication of

this invention.
Like [the device 350 for optical communication shown in drawing 14] the device 150 for optical communication shown in drawing 1 , it consists of a substrate 320 for IC chip mounting, and a multilayer printed wiring board 300, and the substrate 320 for IC chip mounting and the multilayer printed wiring board 300 are electrically connected through the solder connection 337.
Moreover, the closure resin layer 360 is formed between the substrate 320 for IC chip mounting, and the multilayer printed wiring board 300.
[0084]
The configuration of the substrate 320 for IC chip mounting is the configuration and abbreviation identitas of the substrate 120 for IC chip mounting shown in drawing 1 .
moreover, the multilayer printed wiring board 300 — both sides of a substrate 301 — a conductor — the conductor with which laminating formation was carried out and the substrate 301 of the resin insulating layer [a circuit 304 and] 302 between layers was pinched — the conductor which sandwiched circuits and the resin insulating layer 302 between layers — circuits are electrically connected by the through hole 309 and the Bahia hall 307, respectively. Furthermore, the solder resist layer 314 equipped with the solder bump is formed in the outermost layer of a multilayer printed wiring board.
moreover, on the resin insulating layer between layers of the outermost layer of the opposite side whose substrate 301 was pinched the substrate 320 for IC chip mounting of a multilayer printed wiring board 300, and the side which counters So that the optical waveguide 318 equipped with the optical-path conversion mirror 319 may be formed and a lightwave signal can be transmitted between this optical waveguide 318 and the optical path 341 for lightwave signal transmission formed in the substrate 320 for IC chip mounting The optical path 352 for lightwave signal transmission which penetrates a substrate 301, the resin insulating layer 302 between layers and the substrate for IC chip mounting, and the solder resist layer 314 of the side which counters is formed.
In addition, the optical path 351 for lightwave signal transmission should just form these conductor layers and the resin layer for optical paths if needed, although a conductor layer 355 is formed in the wall surface and the resin layer 352 for optical paths is formed in the interior.
In the device for optical communication which consists of such a configuration, a lightwave signal can be transmitted through the optical path 351 for lightwave signal transmission formed in the multilayer printed wiring board 300.
[0085]
Moreover, although optical waveguide is formed on the resin insulating layer between layers of the outermost layer, and the solder resist layer is further formed in the multilayer printed wiring board which constitutes drawing 1 and the device for optical communication shown in 2 and 14 so that this resin insulating layer between layers and optical waveguide may be covered This solder resist layer does not necessarily need to be formed, for example, optical waveguide was formed on [of the outermost layer / whole] the resin insulating layer between layers, and this optical waveguide may play a role of a solder resist layer.
The device for optical communication of this invention which consists of such a configuration can be manufactured by the manufacture approach of the device for optical communication of this invention mentioned later, for example.
[0086]
Next, the manufacture approach of the device for optical communication of this invention is explained.
After the manufacture approach of the device for optical communication of this invention manufactured separately the substrate for IC chip mounting with which the optical element was mounted in the field of 1, and the multilayer printed wiring board with which optical waveguide was formed at least while the optical path for lightwave signal transmission was formed,
Between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it,
Furthermore, after slushing the resin constituent for the closures between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, it is characterized by forming a closure resin layer by performing hardening processing.
[0087]
By the manufacture approach of the device for optical communication of this invention, since a closure resin layer be form among both after arrange and fix the substrate for IC chip mounting, and a multilayer printed wiring board to a position, the device for optical communication with which dust, a foreign matter, etc. which be float the inside of air do not enter between an optical element and optical waveguide, and transmission of a lightwave signal be check can be manufacture suitably.

[0088]
Moreover, it is harder it coming to generate location gap of an optical element and optical waveguide in the obtained device for optical communication by being able to achieve the duty with which this closure resin layer eases the stress which originates in the difference of a coefficient of thermal expansion, and is generated between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, and forming a closure resin layer by forming a closure resin layer between the substrate for IC chip mounting, and a multilayer printed wiring board.
Therefore, by the manufacture approach of this invention, the device for optical communication which is excellent in dependability can be manufactured suitably.
[0089]
By the manufacture approach of the above-mentioned device for optical communication, the substrate for IC chip mounting and a multilayer printed wiring board are manufactured separately first.
Therefore, suppose that the manufacture approach of the substrate for IC chip mounting and the manufacture approach of a multilayer printed wiring board are explained separately, and how to form a closure resin layer is explained after that first here.
[0090]
First, the manufacture approach of the substrate for IC chip mounting is explained.
(1) an insulating substrate — a start ingredient — carrying out — first — this insulating substrate top — a conductor — form a circuit.
As the above-mentioned insulating substrate, a glass epoxy group plate, a polyester substrate, a polyimide substrate, a bismaleimide-triazine resin (BT resin) substrate, a thermosetting polyphenylene ether substrate, copper clad laminate, a RCC substrate, etc. are mentioned, for example.
Moreover, ceramic substrates, such as an alumimium nitride substrate, and a silicon substrate may be used.
the above — a conductor — a circuit can be formed by performing etching processing, after forming a solid conductor layer in the front face of for example, the above-mentioned insulating substrate by nonelectrolytic plating processing etc. Moreover, you may form by performing etching processing to copper clad laminate or a RCC substrate.
[0091]
moreover, the conductor whose above-mentioned insulating substrate was pinched — in making connection between circuits by the through hole, after using a drill, laser, etc. for example, for the above-mentioned insulating substrate and forming a through tube, the through hole is formed by performing nonelectrolytic plating processing etc.
Moreover, when a through hole is formed, it is desirable to be filled up with a resin filler in this through hole.
[0092]
(2) next, the need — responding — a conductor — perform roughening formation processing on the surface of a circuit.
as the above-mentioned roughening formation processing — melanism (oxidization) — the etching processing using the etching reagent containing - reduction processing, the second copper complex, and an organic-acid salt etc., processing by the Cu-nickel-P needlelike alloy plating, etc. can be mentioned.
In addition, before this roughening formation processing is filled up with a resin filler in a through hole, it may be performed, and it may form a roughening side also in the wall surface of a through hole. It is because the adhesion of a through hole and a resin filler improves.
[0093]
(3) next, a conductor — form the resin layer which forms the non-hardened resin layer which consists of thermosetting resin, a photopolymer, the resin with which the photosensitive radical was given to some thermosetting resin, these and thermoplastics, and included resin complex on the substrate in which the circuit was formed, or consists of thermoplastics.
The resin layer which is not hardened [above-mentioned] can be formed by applying non-hardened resin by the roll coater, a curtain coating machine, etc., or carrying out thermocompression bonding of the resin film non-hardened (semi-hardening).
Moreover, the resin layer which consists of the above-mentioned thermoplastics can be formed by carrying out thermocompression bonding of the resin Plastic solid fabricated in the shape of a film.
 [0094]
In these, the approach of carrying out thermocompression bonding of the resin film non-hardened (semi-hardening) is desirable, and sticking by pressure of a resin film can be performed for example, using a vacuum laminator etc.
Moreover, although what is necessary is not to limit especially sticking-by-pressure conditions, but just to choose suitably in consideration of the presentation of a resin film etc., it is usually desirable to carry out on a

pressure 0.25 - 1.0MPa, the temperature of 40-70 degrees C, the degree of vacuum of 13-1300Pa, and about [time amount 10-120 second] conditions.
[0095]
As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyester resin, a bismaleimide resin, polyolefine system resin, polyphenylene ether resin, polyphenylene resin, a fluororesin, etc. are mentioned, for example.
As an example of the above-mentioned epoxy resin, novolak mold epoxy resins, such as a phenol novolak mold and a cresol novolak mold, the cycloaliphatic epoxy resin which carried out dicyclopentadiene conversion are mentioned, for example.
[0096]
As the above-mentioned photopolymer, acrylic resin etc. is mentioned, for example.
Moreover, the thing to which the heat-curing radical, and the methacrylic acid and acrylic acid of the above-mentioned thermosetting resin were made to acrylic--ization-react as resin with which the photosensitive radical was given to some above-mentioned thermosetting resin for example, is mentioned.
[0097]
As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone (PES), polysulfone (PSF), polyphenylene sulfone (PPS) polyphenylene sulfide (PPES), polyphenylene ether (PPE) polyether imide (PI), etc. are mentioned, for example.
[0098]
Moreover, as the above-mentioned resin complex, especially if thermosetting resin, a photopolymer (the resin with which the photosensitive radical was given to some thermosetting resin is also included), and thermoplastics are included, it will not be limited, but as a concrete combination of thermosetting resin and thermoplastics, phenol resin / polyether sulfone, polyimide resin/polysulfone, an epoxy resin / polyether sulfone, an epoxy resin/phenoxy resin, etc. are mentioned, for example. Moreover, as a concrete combination of a photopolymer and thermoplastics, acrylic resin/phenoxy resin, the epoxy resin that acrylic-ized a part of epoxy group, polyether sulfone, etc. are mentioned, for example.
[0099]
Moreover, as for the rate of a compounding ratio of thermosetting resin and the photopolymer in the above-mentioned resin complex, and thermoplastics, thermosetting resin or a photopolymer / thermoplastics =95 / 5 - 50/50 are desirable. It is because a high toughness value is securable, without spoiling thermal resistance.
[0100]
Moreover, the above-mentioned resin layer may consist of resin layers from which it differs more than two-layer.
It is that a lower layer is formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =50/50, and the upper layer is specifically formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =90/10 etc.
While securing the outstanding adhesion with an insulating substrate by making it such a configuration, the formation ease at the time of forming opening for the Bahia halls etc. at a back process is securable.
[0101]
Moreover, the above-mentioned resin layer may be formed using the resin constituent for roughening side formation.
The matter of fusibility is distributed to the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer into the heat-resistant-resin matrix which is not hardened [poorly soluble] to the roughening liquid which serves as the above-mentioned resin constituent for roughening side formation from at least one sort chosen from an acid, alkali, and an oxidizer.
In addition, when the same time amount immersion is carried out, the word of the above "poor solubility" and "fusibility" says relatively what has an early dissolution rate as "fusibility" to the same roughening liquid for convenience, and calls "poor solubility" relatively what has a late dissolution rate to it for convenience.
[0102]
In case the above-mentioned roughening liquid is used for the resin insulating layer between layers and a roughening side is formed as the above-mentioned heat-resistant-resin matrix, what can hold the configuration of a roughening side is desirable, for example, thermosetting resin, thermoplastics, these complex, etc. are mentioned. Moreover, a photopolymer may be used. In addition, when a photopolymer is used, exposure and a development can be used for the resin insulating layer between layers, and opening for the Bahia halls can be formed.
[0103]
As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyolefin resin, a

fluororesin, etc. are mentioned, for example. Moreover, when sensitization-izing the above-mentioned thermosetting resin, a heat-curing radical is made to acrylic(meta)--ization-react using a methacrylic acid, an acrylic acid, etc.
[0104]
As the above-mentioned epoxy resin, a cresol novolak mold epoxy resin, the bisphenol A mold epoxy resin, a bisphenol female mold epoxy resin, a phenol novolak mold epoxy resin, an alkylphenol novolak mold epoxy resin, a biphenol female mold epoxy resin, a naphthalene mold epoxy resin, a dicyclopentadiene mold epoxy resin, the epoxidation object of the condensate of phenols and the aromatic aldehyde which has a phenolic hydroxyl group, triglycidyl isocyanurate, cycloaliphatic epoxy resin, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Thereby, it excels in thermal resistance etc.
[0105]
As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone, polysulfone, polyphenylene sulfone, polyphenylene sulfide, a polyphenyl ether, polyether imide, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.
[0106]
It is desirable that it is at least one sort as which the matter of fusibility is chosen from an inorganic particle, a resin particle, and metal particles to the roughening liquid which consists of at least one sort chosen from the above-mentioned acid, alkali, and an oxidizer.
[0107]
As the above-mentioned inorganic particle, what consists of silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, basic magnesium carbonate, and talc, a silica, and a zeolite, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts.
[0108]
As the above-mentioned resin particle, what consists of thermosetting resin, thermoplastics, etc. is mentioned, for example. When immersed in the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer It will not be limited especially if a dissolution rate is earlier than the above-mentioned heat-resistant-resin matrix. Specifically For example, amino resin (melamine resin, a urea-resin, guanamine resin, etc.), an epoxy resin, phenol resin, phenoxy resin, polyimide resin, polyphenylene resin, polyolefin resin, a fluororesin, bismaleimide-triazine resin, etc. are mentioned. These may be used independently and may be used together two or more sorts.
In addition, the above-mentioned resin particle needs to carry out hardening processing beforehand. It is because the above-mentioned resin particle will dissolve in the solvent in which a resin matrix is dissolved if it is not made to harden.
Moreover, as the above-mentioned resin particle, a rubber particle, liquid phase resin, liquid phase rubber, etc. may be used.
[0109]
As the above-mentioned metal particles, gold, silver, copper, tin, zinc, stainless steel, aluminum, nickel, iron, lead, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.

Moreover, the surface may be covered with resin etc. in order that the above-mentioned metal particles may secure insulation.
[0110]
When two or more sorts are mixed and it uses the matter of the above-mentioned fusibility, as a combination of the matter of two sorts of fusibility to mix, the combination of a resin particle and an inorganic particle is desirable. the resin insulating layer between layers which adjustment of thermal expansion tends to plan them between poorly soluble resin, and they become from the resin constituent for roughening side formation while both of conductivity can be hurt low and can secure the insulation of the resin insulating layer between layers -- a crack -- not generating -- the resin insulating layer between layers, and a conductor -- it is because exfoliation does not occur between circuits.
[0111]
It is desirable to use an organic acid in these as an acid used as the above-mentioned roughening liquid, for example, although organic acids, such as a phosphoric acid, a hydrochloric acid, a sulfuric acid, a nitric acid, and formic acid, an acetic acid, etc. are mentioned. the conductor exposed from the base of the Bahia hall when roughening processing is carried out -- it is because it is hard to make a circuit corrode.
As the above-mentioned oxidizer, it is desirable to, use the water solution of a chromic acid, chromate acid

mixture, and alkaline permanganates (potassium permanganate etc.) etc. for example.
Moreover, as the above-mentioned alkali, water solutions, such as a sodium hydroxide and a potassium hydroxide, are desirable.
[0112]
The mean particle diameter of the matter of the above-mentioned fusibility has desirable 10 micrometers or less.
Moreover, big coarse grain and mean particle diameter may use it combining a small particle relatively relatively [mean particle diameter / the mean particle diameter of 2 micrometers or less]. That is, it is combining the matter of the fusibility whose mean particle diameter's is 0.1-0.5 micrometers, and the matter of the fusibility whose mean particle diameter's is 1-2 micrometers etc.
[0113]
Thus, when big coarse grain and mean particle diameter combine a small particle relatively relatively [particle / average], the dissolution residue of the nonelectrolytic plating film can be lost, the amount of palladium catalysts under plating resist can be lessened, and a still shallower and complicated roughening side can be formed.
Furthermore, by forming a complicated roughening side, even if the irregularity of a roughening side is small, the practical Peel reinforcement is maintainable.
Mean particle diameter exceeds 0.8 micrometers, and that of the above-mentioned coarse grain is less than 2.0 micrometers, and, as for a particle, it is desirable for mean particle diameter to be 0.1-0.8 micrometers.
[0114]
(4) Next, in forming the resin insulating layer between layers using thermosetting resin and resin complex as the ingredient, while performing hardening processing to a non-hardened resin insulating layer, form opening for the Bahia halls and consider as the resin insulating layer between layers. Moreover, at this process, a through tube may be formed if needed.
As for the above-mentioned opening for the Bahia halls, forming by the lasing is desirable. Moreover, when a photopolymer is used as an ingredient of the resin insulating layer between layers, you may form by the exposure development.
[0115]
Moreover, in forming the resin insulating layer between layers using thermoplastics as the ingredient, opening for the Bahia halls is formed in the resin layer which consists of thermoplastics, and it considers as the resin insulating layer between layers. In this case, opening for the Bahia halls can be formed by giving the lasing.
Moreover, what is necessary is just to form this through tube by drilling, the lasing, etc., when forming a through tube at this process.
[0116]
As laser used for the above-mentioned lasing, carbon dioxide gas laser, ultraviolet laser, excimer laser, etc. are mentioned, for example. In these, excimer laser and the carbon dioxide gas laser of a short pulse are desirable.
[0117]
Moreover, it is desirable also in excimer laser to use the excimer laser of a hologram method. A hologram method is a method which irradiates a laser beam through a hologram, a condenser lens, a laser mask, an imprint lens, etc. at the specified substance, and much openings can be once formed in a resin film layer efficiently by exposure by using this method.
[0118]
Moreover, when using carbon dioxide gas laser, as for the pulse separation, it is desirable that they are 10-4 - 10 to 8 seconds. Moreover, as for the time amount which irradiates the laser for forming opening, it is desirable that it is 10 - 500 microseconds.
Moreover, much openings for the Bahia halls can be formed at once by irradiating a laser beam through an optical-system lens and a mask. By minding an optical-system lens and a mask, it is the same reinforcement and is because exposure reinforcement can irradiate the same laser beam at two or more parts.
Thus, after forming opening for the Bahia halls, DESUMIA processing may be performed if needed.
[0119]
(5) next, the front face of the resin insulating layer between layers including the wall of opening for the Bahia halls — a conductor — form a circuit.
a conductor — in forming a circuit, a thin film conductor layer is first formed in the front face of the resin insulating layer between layers.
The above-mentioned thin film conductor layer can be formed by approaches, such as nonelectrolytic plating and sputtering.
[0120]

As the quality of the material of the above-mentioned thin film conductor layer, copper, nickel, tin, zinc, cobalt, a thallium, lead, etc. are mentioned, for example.
In these, what consists of the copper from a point, copper, and nickel which are excellent in an electrical property, economical efficiency, etc. is desirable.
Moreover, when the thickness of the above-mentioned thin film conductor layer forms a thin film conductor layer with nonelectrolytic plating, a desirable minimum is 0.3 micrometers, a more desirable minimum is 0.6 micrometers, a desirable upper limit is 2.0 micrometers and a more desirable upper limit is 1.2 micrometers. Moreover, when forming by sputtering, 0.1-1.0 micrometers is desirable.
[0121]
Moreover, a roughening side may be formed in the front face of the resin insulating layer between layers before forming the above-mentioned thin film conductor layer. By forming a roughening side, the adhesion of the resin insulating layer between layers and a thin film conductor layer can be raised. When the resin insulating layer between layers is especially formed using the resin constituent for roughening side formation, it is desirable to form a roughening side using an acid, an oxidizer, etc.
[0122]
Moreover, when a through tube is formed at the process of the above (4), in case a thin film conductor layer is formed on the resin insulating layer between layers, it is good also as a through hole by forming a thin film conductor layer also in the wall surface of a through tube.
[0123]
(6) Subsequently, form plating resist on the substrate with which the thin film conductor layer was formed in the front face.
After the above-mentioned plating resist sticks for example, a photosensitive dry film, it can carry out adhesion arrangement of the photo mask which consists of a glass substrate with which the plating resist pattern was drawn, and can form it by performing an exposure development.
[0124]
(7) After that, perform electroplating by making a thin film conductor layer into a plating bar, and form an electroplating layer in the above-mentioned plating-resist agenesis section. As the above-mentioned electroplating, copper plating is desirable.
Moreover, the thickness of the above-mentioned electroplating layer has desirable 5-20 micrometers.
[0125]
then, the thing for which the nonelectrolytic plating film and thin film conductor layer under the above-mentioned plating resist and this plating resist are removed — a conductor — a circuit (the Bahia hall is included) can be formed.
What is necessary is just to perform removal of the above-mentioned thin film conductor layer using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, that what is necessary is just to perform removal of the above-mentioned plating resist for example, using an alkali water solution etc.
moreover, the above — a conductor — after forming a circuit, the catalyst on the resin insulating layer between layers may be removed using an acid or an oxidizer if needed. It is because the fall of an electrical property can be prevented.
[0126]
In addition, the conductor indicated here — the conductor in the manufacture approach of this invention although the formation approach of a circuit is an additive process — the formation approach of a circuit may not necessarily be limited to an additive process, for example, may be a subtractive process.
the following and a subtractive process — a conductor — how to form a circuit is explained briefly.
[0127]
That is, after forming first the resin insulating layer between layers which has opening for the Bahia halls, a thin film conductor layer is further formed in the front face of the resin insulating layer between layers containing the wall surface of opening for the Bahia halls like the process of the above (5).
[0128]
Next, thickness of a conductor layer is thickened by forming an electroplating layer etc. the whole surface on the above-mentioned thin film conductor layer. In addition, what is necessary is just to perform formation of an electroplating layer etc. if needed.
Subsequently, etching resist is formed on the above-mentioned conductor layer.
After the above-mentioned etching resist sticks for example, a photosensitive dry film, it carries out adhesion arrangement of the photo mask on this photosensitive dry film, and forms it by performing an exposure development.

[0129]
furthermore, the conductor which became independent on the resin insulating layer between layers by etching processing removing the above-mentioned etching-resist agenesis subordinate's conductor layer, and exfoliating etching resist after that — a circuit (the Bahia hall is included) is formed.
In addition, the above-mentioned etching processing can be performed using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, and exfoliation of etching resist can be performed using an alkali water solution etc.
the case where such an approach is used — the resin insulating-layer top between layers — a conductor — a circuit can be formed.
[0130]
in addition, a conductor — or [whether an additive process is chosen as the formation approach of a circuit, or / choosing a subtractive process] — a conductor — ** is good if it chooses suitably in consideration of numbers, pitches, etc. of a connection terminal, such as the width of face and spacing of a circuit, IC chip to mount, and an optical element, other various electronic parts.
[0131]
Moreover, when a through hole is formed in the above (4) and the process of (5), it may be filled up with a resin filler in this through hole.
Moreover, when filled up with a resin filler in a through hole, a wrap lid plating layer may be formed for the surface section of a resin filler layer by performing nonelectrolytic plating if needed.
[0132]
(8) Next, when a lid plating layer is formed, if needed, roughening processing can be performed on the front face of this lid plating layer, and the resin insulating layer between layers of the outermost layer can be further formed by repeating the process of (3) and (4).
[0133]
(9) repeating the process of (3) - (8) after that if needed — the both sides — a conductor — carry out laminating formation of a circuit and the resin insulating layer between layers. In addition, a through hole may be formed and it is not necessary to form at this process.
performing the process of such (1) - (9) — both sides of a substrate — a conductor — a circuit and the resin insulating layer between layers can manufacture the multilayer-interconnection plate by which laminating formation was carried out.
[0134]
(10) Next, form the through tube which penetrates the above-mentioned multilayer-interconnection plate. The through tube formed here serves as an optical path for lightwave signal transmission in the substrate for IC chip mounting through a back process. Therefore, the through tube formed at this process is hereafter called through tube for optical paths.
[0135]
Drilling, the lasing, etc. perform formation of the above-mentioned through tube for optical paths.
The same thing as the laser used as laser used in the above-mentioned lasing in formation of the above-mentioned opening for the Bahia halls or formation of the above-mentioned opening for solder bump formation etc. is mentioned.
especially the formation location of the above-mentioned through tube for optical paths is limited — not having — a conductor — what is necessary is just to choose suitably in consideration of the mounting position of the design of a circuit, an optical element, and IC chip etc.
Moreover, as for the above-mentioned through tube for optical paths, it is desirable to form for every optical elements, such as a photo detector and a light emitting device. Moreover, you may form for every signal wave length.
[0136]
Moreover, after forming the through tube for optical paths, DESUMIA processing may be performed if needed.
The above-mentioned DESUMIA processing can be performed using processing for example, by the permanganic acid solution, plasma treatment, corona treatment, etc. In addition, by performing the above-mentioned DESUMIA processing, the resin remainder in the through tube for optical paths, weld flash, etc. can be removed, and the transmission loss resulting from the scattered reflection in the wall surface of the optical path for lightwave signal transmission can be reduced.
[0137]
Moreover, after the through tube formation for optical paths, before forming a conductor layer in the wall surface or filling up with the following process into it the resin constituent which is not hardened to the interior, a roughening side may be formed in the wall surface of the through tube for optical paths if needed. By forming a

roughening side, it is because improvement in adhesion with a conductor layer or a resin constituent can be aimed at.
Formation of the above-mentioned roughening side can be performed by dissolving the part exposed with oxidizers, such as acid; chromic acids, such as a sulfuric acid, a hydrochloric acid, and a nitric acid, chromate acid mixture, and a permanganate, etc. when through tubes for optical paths, such as a substrate and a resin insulating layer between layers, were formed. Moreover, plasma treatment, corona treatment, etc. can also perform.
[0138]
Moreover, after forming the through tube for optical paths, it is desirable to form a conductor layer in the wall surface of this through tube for optical paths.
Formation of the above-mentioned conductor layer can be performed by approaches, such as nonelectrolytic plating and sputtering.
After forming the through tube for optical paths, a catalyst nucleus can be given to the wall surface of this through tube for optical paths, and, specifically, the approach immersed in a nonelectrolytic plating bath in the substrate with which the through tube for optical paths was formed can be used after that.
Moreover, the conductor layer which consists of more than two-layer combining nonelectrolytic plating or sputtering may be formed, and the conductor layer which performs electrolysis plating and consists of more than two-layer may be formed after nonelectrolytic plating or sputtering.
[0139]
moreover — while forming a conductor layer in the wall surface of the through tube for optical paths at this process — the resin insulating-layer top between layers of the outermost layer of the above-mentioned multilayer-interconnection plate — the conductor of the outermost layer — it is desirable to form a circuit.
First, in case a conductor layer is formed in the wall surface of the through tube for optical paths with nonelectrolytic plating etc., specifically, a conductor layer is formed also in the whole front face of the resin insulating layer between layers.
[0140]
Next, plating resist is formed on the conductor layer formed in this resin insulating-layer front face between layers. What is necessary is just to perform formation of plating resist by the approach performed at the process of the above (6), the same approach, etc.
[0141]
furthermore, the conductor which became independent on the resin insulating layer between layers by performing electrolysis plating by making into a plating bar the conductor layer formed on the above-mentioned resin insulating layer between layers, forming an electroplating layer in the above-mentioned plating-resist agenesis section, and removing the conductor layer under plating resist and this plating resist after that — a circuit is formed.
[0142]
Moreover, a roughening side may be formed in the wall surface of the above-mentioned conductor layer after forming the above-mentioned conductor layer. What is necessary is just to perform formation of the above-mentioned roughening side by the approach performed at the process of the above (2), the same approach, etc.
[0143]
Moreover, after forming the above-mentioned through tube for optical paths (after forming a conductor layer in that wall surface if needed), it is desirable to be filled up with a non-hardened resin constituent in this through tube for optical paths. After being filled up with a non-hardened resin constituent, it can consider as the optical path for lightwave signal transmission by which the resin layer for optical paths was formed in the interior by performing hardening processing.
It is not limited especially as an approach filled up with a non-hardened resin constituent, for example, approaches, such as printing and potting, can be used.
In addition, when filled up with a non-hardened resin constituent by printing, it may be filled up with this resin constituent at once, and it may be printed in 2 steps or more. Moreover, printing may be performed from the both sides of a multilayer-interconnection plate.
[0144]
Moreover, in case it is filled up with a non-hardened resin constituent, it may be filled up with the resin constituent which is not hardened [of somewhat many amounts], and the excessive resin constituent with which it overflowed from the through tube for optical paths may be removed from the inner product of the above-mentioned through tube for optical paths after restoration termination.
the above — polish etc. can perform removal of an excessive resin constituent. Moreover, what is necessary is for the condition of a resin constituent to be in a semi-hardening condition, to be in the condition hardened

completely, and just to choose it suitably in consideration of the ingredient of a resin constituent etc., when removing an excessive resin constituent.

[0145]

By performing such processing, the optical path for lightwave signal transmission which penetrates the above-mentioned multilayer-interconnection plate can be formed.

the conductor which became independent by forming a conductor layer also in the front face of the resin insulating layer between layers, and performing processing mentioned above in case a conductor layer is formed in the wall surface of the above-mentioned through tube for optical paths — a circuit can be formed. of course, the conductor which became independent on the resin insulating layer between layers by the approach mentioned above even if it was the case where the above-mentioned conductor layer was not formed — what is necessary is just to form a circuit

[0146]

(11) next, a conductor — form a solder resist layer in the outermost layer of the substrate in which the circuit and the resin insulating layer between layers were formed.

The above-mentioned solder resist layer can be formed using the solder resist constituent which consists of for example, polyphenylene ether resin, polyolefin resin, a fluororesin, thermoplastic elastomer, an epoxy resin, polyimide resin, etc.

[0147]

moreover, as solder resist constituents other than the above For example, the acrylate (meta) of a novolak mold epoxy resin, an imidazole curing agent, 2 functionality (meta) acrylic ester monomer, the polymer of with a molecular weight of about 500 to 5000 acrylic ester (meta), The fluid of the shape of a paste containing photosensitive monomers, such as thermosetting resin which consists of a bisphenol mold epoxy resin etc., and a multiple-valued acrylic monomer, a glycol ether system solvent, etc. is mentioned, and, as for the viscosity, it is desirable to be adjusted to 1 - 10 Pa-s at 25 degrees C. Moreover, a commercial solder resist constituent may be used.

Moreover, at this process, the film which consists of the above-mentioned solder resist constituent is stuck by pressure, and the layer of a solder resist constituent may be formed.

[0148]

(12) Next, form opening (henceforth opening for optical paths) which was open for free passage in the layer of the above-mentioned solder resist constituent at the above-mentioned through tube for optical paths, and consider as a solder resist layer.

Specifically, it forms by the approach of forming opening for the Bahia halls, and the same approach, i.e., an exposure development, the lasing, etc.

Moreover, in case the above-mentioned opening for optical paths is formed, it is desirable to form opening for solder bump formation (opening for mounting IC chip and an optical element and opening for connecting with a multilayer printed wiring board) in coincidence. In addition, formation of the above-mentioned opening for optical paths and formation of the above-mentioned opening for solder bump formation are separately good in a line.

[0149]

Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for optical paths and opening for solder bump formation may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.

By passing through such a process of (11) and (12), the solder resist layer which has this through tube for optical paths and opening which was open for free passage can be formed on the multilayer-interconnection plate in which the through tube for optical paths was formed.

In addition, the path of the above-mentioned opening for optical paths may be the same as that of the path of the above-mentioned through tube for optical paths, and may be smaller than the path of the above-mentioned through tube for optical paths.

[0150]

Moreover, when the resin layer for optical paths is formed in the through tube for optical paths at the process of the above (10), it is desirable by filling up a non-hardened resin constituent also with this process, and performing hardening processing after that in opening for optical paths, at it to form the resin layer for optical paths.

The resin layer for optical paths will be formed in the whole interior of the optical path for lightwave signal transmission by forming the resin layer for optical paths also in this process.

Moreover, as a resin constituent which is not hardened [with which it is filled up in the above-mentioned opening for optical paths], it is the process of the above (10) and it is desirable that it is the same as that of the resin constituent which is not hardened [with which it is filled up in the through tube for optical paths].

[0151]
moreover, in forming the optical path for lightwave signal transmission by which the resin layer for optical paths was formed in the whole interior In the process of the above (10), it is not filled up with a non-hardened resin constituent, but sets at this process. It is good also as an optical path for lightwave signal transmission by which the resin layer for optical paths was formed in the whole interior by being filled up with a non-hardened resin constituent in opening for optical paths which was open for free passage to the inside of the through tube for optical paths, and this, and performing hardening processing after that.
[0152]
Moreover, after filling up the through tube for optical paths with a non-hardened resin constituent in the process of the above (10), The solder resist layer which has opening for optical paths by the approach which was made to carry out semi-hardening of this resin constituent, and mentioned it above after that is formed. Furthermore, after being filled up with a non-hardened resin constituent in the above-mentioned opening for optical paths, the resin layer for optical paths may be formed by performing hardening processing to the resin constituent in the through tube for optical paths, and the resin constituent in opening for optical paths at coincidence.
[0153]
(13) Next, arrange a micro lens in the edge of the optical path for lightwave signal transmission if needed. Although what is necessary is just to arrange in the edge of the optical path for lightwave signal transmission through the adhesives layer formed on the solder resist layer in order to arrange a micro lens in the edge of the above-mentioned optical path for lightwave signal transmission, when the resin layer for optical paths is especially formed in the interior of the optical path for lightwave signal transmission, on this resin layer for optical paths, it may arrange directly or you may arrange through a transparent adhesives layer.
[0154]
As an approach of arranging a micro lens directly on the above-mentioned resin layer for optical paths, optimum dose dropping of the non-hardened resin for optical lenses is carried out on the resin layer for optical paths, and this method of performing hardening processing etc. is mentioned to the resin for optical lenses which is not hardened [which was dropped], for example.
In case optimum dose dropping of the resin for optical lenses which is not hardened [above-mentioned] is carried out on the resin layer for optical paths, equipments, such as a dispenser, an ink jet, a micropipette, and a micro syringe, can be used.
Since the resin for optical lenses which is not hardened [which was dropped on the resin layer for optical paths using such equipment] tends to become a globular form with the surface tension, it becomes hemispherical on the above-mentioned resin layer for optical paths, and a semi-sphere-like micro lens (lens of a convex configuration) can be arranged on the resin layer for optical paths by performing hardening processing to the resin for optical lenses which is not semi-sphere-like hardened after that.
In addition, a diameter of a micro lens, a configuration of a curved surface, etc. which are formed by the approach mentioned above are controllable by adjusting the viscosity of the non-hardened resin for optical lenses etc. suitably, taking into consideration the wettability of a resin constituent and the non-hardened resin for optical lenses.
[0155]
(14) next, the conductor exposed by forming the above-mentioned opening for solder bump formation — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, and let it be a solder pad. In these, it is desirable to form an enveloping layer with metals, such as nickel-gold, nickel-silver, nickel-palladium, and nickel-palladium-gold.
Although the above-mentioned enveloping layer can be formed according to plating, vacuum evaporationo, electrodeposition, etc., in these, it is desirable to form with plating from the point of excelling in the homogeneity of an enveloping layer.
[0156]
(15) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to opening (opening for IC chip mounting) for mounting IC chip, and opening (opening for multilayer printed wiring board connection) for connecting with a multilayer printed wiring board.
By forming such a solder bump, it becomes possible to mount IC chip or to connect a multilayer printed wiring board through this solder bump. In addition, that what is necessary is just to form if needed, even if this solder bump is the case where a solder bump is not formed, she can connect these and the substrate for IC chip mounting electrically through the bump of IC chip to mount or the multilayer printed wiring board to connect.
[0157]
(16) An optical element (a photo detector and light emitting device) is further mounted in a solder resist layer.

Nhat is necessary is for mounting of an optical element to fill up soldering paste with the process of the above :15) also into opening (opening for optical element mounting) for mounting an optical element, and just to mount t through solder further, by attaching the above-mentioned optical element, in case a reflow is performed. Moreover, it may replace with soldering paste and an optical element may be mounted using electroconductive glue etc.
By passing through such a process, the substrate for IC chip mounting which constitutes the device for optical communication of this invention can be manufactured.
[0158]
Next, the manufacture approach of a multilayer printed wiring board is explained.
(1) first — the process of (1) - (2) of the manufacture approach of the above-mentioned substrate for IC chip mounting — the same — carrying out — both sides of a substrate — a conductor — the conductor which forms a circuit and whose substrate was both pinched — form the through hole which connects between circuits. moreover — this process — a conductor — a roughening side is formed in the front face of a circuit, or the wall surface of a through hole if needed.
[0159]
(2) next, the need — responding — a conductor — a substrate [in which the circuit was formed] top — the resin insulating layer between layers, and a conductor — carry out laminating formation of the circuit.
concrete — the same approach as the process of (3) - (8) of the manufacture approach of the above-mentioned substrate for IC chip mounting — using — the resin insulating layer between layers, and a conductor — what is necessary is just to carry out laminating formation of the circuit
Also in this process, the through hole which penetrates a substrate and the resin insulating layer between layers may be formed like the case where the substrate for IC chip mounting is manufactured, or a lid plating layer may be formed.
In addition, this process of (2), i.e., the resin insulating layer between layers, and a conductor — the process which carries out the laminating of the circuit may be performed once, and is good in a multiple-times line. moreover, this process — the resin insulating-layer top between layers — a conductor — a subtractive process may be used like the case where the substrate for IC chip mounting is manufactured, as an approach of forming a circuit.
[0160]
(3) next, the conductor on the substrate for IC chip mounting, the substrate of the side which counters, or the resin insulating layer between layers — form optical waveguide in the circuit agenesis section.
Formation of the above-mentioned optical waveguide can be performed by attaching beforehand the optical waveguide fabricated in the predetermined configuration through adhesives, when carrying out by using inorganic materials, such as quartz glass, for the ingredient.
moreover, the optical waveguide which consists of the above-mentioned inorganic material — for example, LiNbO3 and LiTaO3 etc. — it can form by making an inorganic material form by the liquid-phase-epitaxial method, the chemistry depositing method (CVD), a molecular beam epitaxy, etc.
[0161]
As an approach of forming the optical waveguide which consists of a polymer ingredient, for example Moreover, **1 The approach of sticking the film for optical waveguide formation beforehand fabricated in the shape of a film to mold releasing film superiors on the resin insulating layer between layers, and **2 The approach of forming direct optical waveguide on the above-mentioned resin insulating layer between layers etc. is mentioned by carrying out laminating formation of a lower clad, a core, and the up clad one by one on the resin insulating layer between layers.
In addition, as the formation approach of optical waveguide, also when forming optical waveguide on a mold releasing film, and also when forming optical waveguide on the resin insulating layer between layers, it can carry out using the same approach.
Specifically, the approach using reactive ion etching, the exposure developing-negatives method, the metal mold forming method, the resist forming method, the approach that combined these can be used.
[0162]
The approach using the above-mentioned reactive ion etching — (i) — first, a lower clad is formed on a mold releasing film, the resin insulating layer between layers (only henceforth a mold releasing film etc.), etc., the resin constituent for cores is applied on (ii), next this lower clad, and it considers as the resin layer for core formation by performing hardening processing further if needed. (iii) Next, a mask (etching resist) is formed on the resin layer for core formation by forming the resin layer for mask formation on the above-mentioned resin layer for core formation, and subsequently performing an exposure development to the resin layer for this mask formation.

[0163]

(iv) Next, by giving reactive ion etching to the resin layer for core formation, the resin layer for core formation of a mask agenesis part is removed, and a core is formed on a lower clad. (v) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.

The approach using this reactive ion etching can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.

[0164]

moreover — the exposure developing-negatives method — (i) — first, a lower clad is formed on a mold releasing film etc., the resin constituent for cores is applied on (ii), next this lower clad, and the layer of the resin constituent for core formation is further formed by performing semi-hardening if needed.

[0165]

(iii) Next, a core is formed on a lower clad by laying the mask with which the pattern corresponding to a core formation part was drawn on the layer of the above-mentioned resin constituent for core formation, and performing an exposure development after that. (iv) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.

Since there are few routing counters, in case this exposure developing-negatives method mass-produces optical waveguide, it can be used suitably, and since there are few heating processes, stress cannot generate it easily in optical waveguide.

[0166]

moreover — the above-mentioned metal mold forming method — (i) — first, a lower clad is formed on a mold releasing film etc., and the slot for core formation is formed in (ii), next a lower clad by metal mold formation. (iii) Further, above-mentioned Mizouchi is filled up with the resin constituent for cores by printing, and a core is formed by performing hardening processing after that. (iv) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.

In case this metal mold forming method mass-produces optical waveguide, it can be used suitably, and it can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.

[0167]

moreover — the above-mentioned resist forming method — (i) — first — a mold releasing film etc. top — a lower clad — forming — (ii) — further, after applying the resin constituent for resists on this lower clad, resist formation for core formation is carried out by performing an exposure development at the core agenesis part on the above-mentioned lower clad.

[0168]

(iii) Next, after the resin constituent for cores applying to the resist agenesis part on a lower clad and hardening the resin constituent for cores to the (iv) pan, a core is formed on a lower clad by exfoliating the above-mentioned resist for core formation. (v) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.

In case this metal mold forming method mass-produces optical waveguide, it can be suitably used for this resist forming method, and it can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.

[0169]

Moreover, an optical-path conversion mirror is formed in the above-mentioned optical waveguide.

Although it may be formed before the above-mentioned optical-path conversion mirror attaches optical waveguide on the resin insulating layer between layers, and it may be formed after attaching it on the resin insulating layer between layers, it is desirable to form an optical-path conversion mirror beforehand except for the case where this optical waveguide is directly formed on the resin insulating layer between layers. other members which can work easily and constitute a multilayer printed wiring board at the time of an activity, for example, a substrate, and a conductor — it is because a blemish is attached to a circuit, the resin insulating layer between layers, etc. or there is no possibility of damaging these.

[0170]

It is not limited especially as an approach of forming the above-mentioned optical-path conversion mirror, but the well-known formation approach can be used conventionally. Specifically, machining with the diamond saw and cutter whose tip is 90 degrees of V types, processing by reactive ion etching, laser ablation, etc. can be used.

In addition, although how to form optical waveguide on the substrate of the side which counters the substrate for IC chip mounting, or the resin insulating layer between layers of the outermost layer is explained, when manufacturing the above-mentioned multilayer printed wiring board, the above-mentioned optical waveguide may be formed here between a substrate and the resin insulating layer between layers, and among the resin insulating

ayers between layers.

[0171]

In forming optical waveguide between a substrate and the resin insulating layer between layers the process of the above (1) — the both sides — a conductor, after producing the substrate with which the circuit was formed the same approach as the process of the above (3) — the conductor on a substrate — optical waveguide can be formed in the above-mentioned location by forming optical waveguide in a circuit agenesis part, and forming the resin insulating layer between layers by the same approach as the process of the above (2) after that.

[0172]

moreover, in forming optical waveguide among the resin insulating layers between layers the above (1) and the process of (2) — the same — carrying out — a conductor, after carrying out laminating formation of the resin insulating layer between at least one-layer layers on the substrate with which the circuit was formed Optical waveguide can be formed among the resin insulating layers between layers by forming optical waveguide on the resin insulating layer between layers like the process of the above (3), and repeating the process of the above (2), and the same process after that further.

[0173]

Furthermore, it sets to the multilayer printed wiring board which constitutes the device for optical communication of this invention. In manufacturing the multilayer printed wiring board with which optical waveguide may be formed in the opposite side whose substrate was pinched the side which counters the substrate for IC chip mounting, and optical waveguide was formed in such a location Although it is necessary to form the optical path for lightwave signal transmission which penetrates a substrate at least so that a lightwave signal can be transmitted between the above-mentioned optical waveguide and the optical element mounted in the above-mentioned substrate for IC chip mounting What is necessary is just to form suitably such an optical path for lightwave signal transmission, before forming optical waveguide, or after forming optical waveguide.

[0174]

By passing through the above (1) and the process of (2) specifically After producing a multilayer-interconnection plate, before forming optical waveguide, the same approach as the process of (10) of the manufacture approach of the substrate for IC chip mounting is used. What is necessary is to form the through tube for optical paths, to form optical waveguide and just to consider as a multilayer printed wiring board through the process mentioned later further after that, in the location which can transmit a lightwave signal between the substrates for IC chip mounting through the above-mentioned through tube for optical paths by the approach mentioned above. In addition, after forming the above-mentioned through tube for optical paths, the resin layer for optical paths and a conductor layer may be formed in the interior and wall surface if needed.

[0175]

(4) Next, form a solder resist layer in the outermost layer of the substrate in which optical waveguide was formed.

The above-mentioned solder resist layer can be formed using the resin constituent used when forming the solder resist layer of for example, the above-mentioned substrate for IC chip mounting, and the same resin constituent.

In addition, depending on the case, optical waveguide is formed in the whole outermost layer of a substrate at the process of the above (3), and you may make it optical waveguide play a role of a solder resist layer.

[0176]

(5) Next, form opening for solder bump formation (opening for mounting the substrate for IC chip mounting, and various surface mount mold electronic parts), and opening for optical paths in the substrate for IC chip mounting, and the solder resist layer of the side which counters.

Formation with the above-mentioned opening for solder bump formation and opening for optical paths can be performed to the substrate for IC chip mounting using the approach of forming opening for solder bump formation, and the same approach, i.e., an exposure development, the lasing, etc.

In addition, formation of the above-mentioned opening for solder bump formation and formation of opening for optical paths may be performed to coincidence, and are separately good in a line.

[0177]

In these, in case a solder resist layer is formed, it is desirable to choose the approach of forming opening for solder bump formation and opening for optical paths by applying the resin constituent which contains a photopolymer as the ingredient, and performing an exposure development.

It is because there is no possibility of attaching a blemish to the optical waveguide which exists under this opening for optical paths, at the time of opening formation in forming opening for optical paths by the exposure development.

Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for solder bump

formation and opening for optical paths may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.
In addition, in forming the through tube for optical paths and forming optical waveguide in the opposite side whose substrate was pinched the substrate for IC chip mounting, and the side which counters, in case it forms opening for optical paths at this process, it forms so that opening for optical paths may be opened for free passage with the above-mentioned through tube for optical paths.
[0178]
Moreover, opening for solder bump formation may be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and the opposite side if needed.
By passing through a back process, it is because an external connection terminal can be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and the opposite side.
[0179]
(6) next, the conductor exposed by forming the above-mentioned opening for solder bump formation — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, and let it be a solder pad. What is necessary is just to specifically carry out using the same approach as the process of (14) of the manufacture approach of the substrate for IC chip mounting.
[0180]
(7) Next, in opening for optical paths formed at the process of the above (5), it is filled up with a non-hardened resin constituent and form the resin layer for optical paths by performing hardening processing after that if needed.
In addition, the resin constituent which is not hardened [which is filled up with this process] is the production process of the substrate for IC chip mounting, and it is desirable that it is the same as that of the resin constituent with which the through tube for optical paths and opening for optical paths are filled up.
Moreover, as mentioned above, in order to form optical waveguide in the opposite side whose substrate was pinched the substrate for IC chip mounting, and the side which counters What is necessary is to fill up this through tube for optical paths, and this opening for optical paths with a non-hardened resin constituent, and just to use the approach of using as an approach filled up with a non-hardened resin constituent in this case, in case the substrate for IC chip mounting is manufactured, and the same approach, also when the through tube for optical paths and opening for optical paths are formed.
[0181]
(8) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-mentioned solder pad.
By forming such a solder bump, it becomes possible to mount the substrate for IC chip mounting, and various surface mount mold electronic parts through this solder bump. In addition, that what is necessary is just to form if needed, even if this solder bump is the case where a solder bump is not formed, she can mount these through the bump of the substrate for IC chip mounting, or various surface mount mold electronic parts who mounts.
Moreover, it is good also as PGA (Pin Grid Array) or BGA (Ball Grid Array) by not forming an external connection terminal, arranging a pin or forming a solder ball if needed, especially in the solder resist layer of the substrate for IC chip mounting, the field which counters, and the opposite side.
By passing through such a process, the substrate for IC chip mounting which constitutes the device for optical communication of this invention can be manufactured.
[0182]
By the manufacture approach of the device for optical communication of this invention next, both are stationed in the location which can perform transmission of a lightwave signal through the optical path for lightwave signal transmission formed in the substrate for IC chip mounting between the optical element of the substrate for IC chip mounting, and the optical waveguide of a multilayer printed wiring board, and it fixes to it.
Here, both are fixed, while forming a solder connection by the solder bump of the above-mentioned substrate for IC chip mounting, and the solder bump of the above-mentioned multilayer printed wiring board and connecting both electrically, after carrying out opposite arrangement of the substrate for IC chip mounting, and the multilayer printed wiring board. That is, both are connected by carrying out opposite arrangement and carrying out a reflow of the substrate for IC chip mounting, and the multilayer printed wiring board to a position with the predetermined sense, respectively.
In addition, as mentioned above, the solder bump for fixing both substrate for IC chip mounting and multilayer printed wiring board may be formed only in one of both.
[0183]
Moreover, at this process, even if some location gap exists among both when opposite arrangement of both is

carried out in order to connect the substrate for IC chip mounting, and a multilayer printed wiring board using both solder bump, both can be stationed to a position according to the self-alignment effectiveness which solder has at the time of a reflow.
[0184]
Next, the resin constituent for the closures is slushed between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, and a closure resin layer is formed in it by performing hardening processing after that.
Silicone resin mentioned above as the above-mentioned resin constituent for the closures, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA; that with which resinous principles, such as a polymer manufactured from benz-cyclo-butene, and the particle contained if needed were resembled, in addition various additives, such as a curing agent, a defoaming agent, an acid anhydride, and a solvent, were blended suitably is mentioned.
Moreover, as for the above-mentioned resin constituent for the closures, it is desirable for the permeability of the communication link wavelength light after hardening to be 70% or more, and it is more desirable that it is 90% or more.
[0185]
What is necessary is here, just to choose suitably in consideration of the design of the presentation of the resin constituent for the closures, the substrate for IC chip mounting, and a multilayer printed wiring board etc. as the viscosity of the resin constituent for the closures slushed between the substrate for IC chip mounting, and a multilayer printed wiring board, and conditions for the hardening processing after slushing this resin constituent for the closures.
[0186]
Next, IC chip is mounted in the substrate for IC chip mounting, and it considers as the device for optical communication by performing the resin seal of IC chip after that if needed.
Mounting of the above-mentioned IC chip can be conventionally performed by the well-known approach.
Moreover, it is good also as a device for optical communication by connecting the substrate for IC chip mounting and multilayer printed wiring board which performed mounting of IC chip before connecting the substrate for IC chip mounting, and a multilayer printed wiring board, and mounted IC chip.
[0187]
[Example]
Hereafter, this invention is further explained to a detail.
(Example 1)
A. Production of the substrate for IC chip mounting
A-1. Production of the resin film for the resin insulating layers between layers
The bisphenol A mold epoxy resin (weight-per-epoxy-equivalent 469, Epicoat 1001 by oil-ized shell epoxy company) 30 weight section, The cresol novolak mold epoxy resin (weight-per-epoxy-equivalent 215, Epiclon N-673 by Dainippon Ink & Chemicals, Inc.) 40 weight section, The triazine structure content phenol novolak resin (phenol nature hydroxyl equivalent 120, FENO [by Dainippon Ink & Chemicals, Inc.] light KA- 7052) 30 weight section The ethyl diethylene glycol acetate 20 weight section, The heating dissolution is carried out stirring in the solvent naphtha 20 weight section. There The end epoxidation polybutadiene rubber (Nagase Brothers formation DENAREKKUSU R-45 by industrial company EPT) 15 weight section, and the 2-phenyl -4, the 5-screw (hydroxymethyl) imidazole grinding article 1.5 weight section, The pulverizing silica 2 weight section and the silicone system defoaming agent 0.5 weight section were added, and the epoxy resin constituent was prepared.
After applying using a roll coater so that the thickness after drying the obtained epoxy resin constituent on a PET film with a thickness of 38 micrometers may be set to 50 micrometers, the resin film for the resin insulating layers between layers was produced by making it dry for 10 minutes at 80-120 degrees C.
[0188]
A-2. Preparation of the resin constituent for through tube restoration
The mean particle diameter by which coating of the silane coupling agent was carried out to the bisphenol female mold epoxy monomer (oil-ized shell company make, molecular weight : 310 YL983U) 100 weight section and a front face by 1.6 micrometers The diameter of grain of maximum size for a container the SiO2 spherical-particle (Adtec Corp. make, CRS 1101-CE) 170 weight section 15 micrometers or less and the leveling agent (Sannopuko PERENORU S4) 1.5 weight section by carrying out stirring mixing The viscosity prepared the resin filler of 45-49Pa and s at 23**1 degree C. In addition, the imidazole curing agent (Shikoku formation shrine make, 2E4 MZ-CN) 6.5 weight section was used as a curing agent.

[0189]
A-3. Manufacture of the substrate for IC chip mounting
(1) Copper clad laminate which 18-micrometer copper foil 28 laminates to both sides of the insulating substrate 21 which consists of a glass epoxy resin with a thickness of 0.8mm or BT (bismaleimide triazine) resin was used as the start ingredient (refer to drawing 3 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern — both sides of a substrate 21 — a conductor — the circuit 24 and the through hole 29 were formed (refer to drawing 3 (b)).
[0190]
(2) Wash in cold water the substrate in which the circuit 24 was formed. a through hole 29 and a conductor — NaOH (10 g/l), NaClO2 after drying (40 g/l), the water solution containing Na3PO4 (6 g/l) — melanism — the melanism made into a bath (oxidation bath) — the conductor which performs reduction processing which makes a reduction bath processing and NaOH (10 g/l), and the water solution containing NaBH4 (6g/(l.)), and includes a through hole 29 — the roughening side (not shown) was formed in the front face of a circuit 24.
[0191]
(3) the following approach after preparing the resin filler indicated to the above A-2 — after preparation — less than 24 hours — the conductor in a through hole 29 and on a substrate 21 — the circuit agenesis section and a conductor — the layer of resin filler 30' was formed in the rim section of a circuit 24.
That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 30' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 3 (c)).
[0192]
(4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 30' might remain neither in the front face of a circuit 24, nor the land front face of a through hole 29, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate.
Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 30 was formed.
[0193]
thus, a through hole 29 and a conductor — the surface section of the resin filler 30 formed in the circuit agenesis section, and a conductor — the front face of a circuit 24 — flattening — carrying out — the resin filler 30 and a conductor — the insulating substrate which the side face of a circuit 24 stuck firmly through the roughening side, and the internal surface and the resin filler 30 of a through hole 29 stuck firmly through the roughening side was obtained (refer to drawing 3 (d)). this process — the front face of the resin filler layer 30, and a conductor — the front face of a circuit 24 turns into the same flat surface.
[0194]
(5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 24, and the land front face of a through hole 29 — a conductor — the roughening side (not shown) was formed in all the front faces of a circuit 24. As an etching reagent, the etching reagent (the product made from MEKKU, MEKKU dirty bond) containing the imidazole copper (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.
[0195]
(6) Next, the somewhat larger resin film for the resin insulating layers between layers than the substrate produced by the above A-1 was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the resin insulating layer 22 between layers was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 3 (e)).
That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.
[0196]
(7) Next, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 22 between layers by CO2 gas laser with a wavelength of 10.4 micrometers through the mask with which

the through tube with a thickness of 1.2mm was formed on the resin insulating layer 22 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the through tube of a mask, and the conditions of one shot (refer to drawing 4 (a)).

[0197]

(8) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution removal of the epoxy resin particle which exists in the front face of the resin insulating layer 22 between layers.

[0198]

(9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI).

Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the resin insulating layer 22 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride ($PdCl_2$) and a stannous chloride ($SnCl_2$), and the catalyst was given by depositing a palladium metal.

[0199]

(10) Next, into the non-electrolytic copper plating water solution of the following presentations, the substrate was immersed and the non-electrolytic copper plating film 32 with a thickness of 0.6-3.0 micrometers was formed on the front face (the internal surface of the opening 26 for the Bahia halls is included) of the resin insulating layer 22 between layers (refer to drawing 4 (b)).

[0200]

[Nonelectrolytic plating water solution]
$NiSO_4$ 0.003 mol/l
Tartaric acid 0.200 mol/l
Copper sulfate 0.030 mol/l
HCHO 0.050 mol/l
NaOH 0.100 mol/l
alpha and alpha'-bipyridyl 100 mg/l
Polyethylene-glycol (PEG) 0.10 g/l
[Nonelectrolytic plating conditions]
It is 40 minutes by whenever [30-degree C solution temperature].

[0201]

(11) Next, the plating resist 23 with a thickness of 20 micrometers was formed by sticking a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 32 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 4 (c)).

[0202]

(12) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was formed in the plating-resist 23 agenesis section (refer to drawing 4 (d)).

[0203]

[Electrolysis plating liquid]
Sulfuric acid 2.24 mol/l
Copper sulfate 0.26 mol/l
Additive 19.5 ml/l
(Made in ATOTEKKU Japan, KAPARASHIDO GL)
[Electrolysis plating conditions]
Current density 1 A/dm2
Time amount 65 Part
Temperature 22**2 **

[0204]

(13) -- a conductor with a thickness of 18 micrometers which carries out etching processing of the nonelectrolytic plating film under plating resist 23 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution removal and consists of non-electrolytic copper plating film 32 and electrolytic

copper plating film 33 further after carrying out exfoliation removal of the plating resist 23 by NaOH 5% — the circuit 25 (the Bahia hall 27 is included) was formed (refer to drawing 5 (a)).

[0205]

A roughening side (not shown) is formed in the front face of a circuit 25. (14) — the still more nearly same etching reagent as the etching reagent used at the process of the above (5) — using — a conductor — subsequently The above (6) It has the opening 26 for the Bahia halls like the process of – (8), and laminating formation of the resin insulating layer 22 between layers by which the roughening side (not shown) was formed in the front face was carried out (refer to drawing 5 (b)).

Then, the through tube 46 for optical paths which penetrates a substrate 21 and the resin insulating layer 22 between layers was formed using the drill with a diameter of 300 micrometers, and DESUMIA processing was further performed to the wall surface of the through tube 46 for optical paths (refer to drawing 5 (c)). In addition, what is necessary is just to usually use a drill with a diameter of about 200-400 micrometers in this example, in forming the through tube for optical paths although the through tube for optical paths is formed using a drill with a diameter of 300 micrometers.

[0206]

(15) Next, give a catalyst to the wall surface of the through tube 46 for optical paths, and the front face of the resin insulating layer 22 between layers by the approach used at the process of the above (9), and the same approach. Furthermore, in the nonelectrolytic plating liquid used at the process of the above (10), and the same non-electrolytic copper plating water solution The substrate was immersed and the thin film conductor layer (non-electrolytic copper plating film) 32 was formed in the front face (the internal surface of the opening 26 for the Bahia halls is included) of the resin insulating layer 22 between layers, and the wall surface of the through tube 46 for optical paths (refer to drawing 6 (a)).

[0207]

(16) Next, plating resist 23 was formed by the approach used at the process of the above (11), and the same approach, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was further formed in the plating-resist 23 agenesis section by the approach used at the process of the above (12), and the same approach (refer to drawing 6 (b)).

[0208]

(17) next, the approach used at the process of the above (13) and the same approach — exfoliation of plating resist 23, and removal of the thin film conductor layer under plating resist 23 — carrying out — a conductor — the circuit 25 (the Bahia hall 27 is included) and the conductor layer 45 were formed.

furthermore, the approach used at the process of the above (2) and the same approach — oxidation reduction processing — carrying out — a conductor — the front face of a circuit 25 and the front face of a conductor layer 45 were made into the roughening side (not shown) (refer to drawing 6 (c)).

[0209]

(18) Next, after being filled up with the resin constituent containing an epoxy resin and making it dry using a squeegee in the through tube 46 for optical paths in which the conductor layer 45 was formed, flattening of the surface was carried out by buffing. Furthermore, hardening processing was performed and the resin layer 42 for optical paths was formed (refer to drawing 7 (a)).

[0210]

(19) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make —) dissolved in the methyl ethyl ketone trade name: — the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku — formation — shrine make —) trade name: — 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make —) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: — the R604 4.5 weight section — the same — a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make —) trade name: — the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make —) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C was obtained by adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent.

In addition, in the case of 60min-1 (rpm), in the case of rotor No.4 and 6min-1 (rpm), measurement of viscosity was based on rotor No.3 by the Brookfield viscometer (the Tokyo Keiki Co., Ltd. make, DVL-B mold).

[0211]

(20) next, the resin insulating layer 22 between layers and a conductor — the above-mentioned solder resist

constituent was applied by the thickness of 30 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of the substrate in which the circuit 25 (the Bahia hall 27 is included) was formed, the condition for 30 minutes at 70 degrees C, and layer 34' of a solder REJISU constituent was formed in them (refer to drawing 7 (b)).
[0212]
(21) Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening for optical paths and opening for solder bump formation (opening for IC chip mounting and opening for optical element mounting) was drawn was stuck to layer 34' of the solder resist constituent by the side of IC chip mounting, it exposed by the ultraviolet rays of 1000 mJ/cm2, the development was carried out with the DMTG solution, and opening was formed. And further, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, a solder resist layer is stiffened, it has the opening 31 for optical paths, and the opening 35 for solder bump formation, and the solder resist layer 34 the thickness of whose is 20 micrometers was formed.
Moreover, the opening 35 for solder bump formation for connecting with a multilayer printed wiring board was formed in the layer of the solder resist constituent of another side by sticking the photo mask with which the pattern of opening for solder bump formation (opening for multilayer printed wiring board connection) was drawn, and performing an exposure development on the above-mentioned exposure development conditions and the same conditions (refer to drawing 8 (a)).
[0213]
(22) Next, it was filled up with the resin constituent containing the epoxy resin filled up with the process of the above (18) in opening for optical paths formed at the process of the above (21), and the same resin constituent using the squeegee, and after making it dry, flattening of the surface was carried out by buffing. Furthermore, hardening processing was performed and the resin layer 42 for optical paths was formed.
In addition, permeability is 85% and the refractive index of the resin layer for optical paths formed at this process and the process of the above (18) is 1.60.
[0214]
(23) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer with a thickness of 5 micrometers was formed in the opening 35 for solder bump formation, and the opening 31 for optical elements.
Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10 to 1 mol/l.), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the solder pad 36.
[0215]
(24) Next, print soldering paste to the opening 35 for solder bump formation formed in the solder resist layer 34. Furthermore, by attaching a photo detector 38 and a light emitting device 39 in the soldering paste printed to opening for optical element mounting, performing alignment of each light sensing portion 38a and light-emitting part 39a, and carrying out a reflow to it at 200 degrees C While mounting the photo detector 38 and the light emitting device 39 through solder, the solder bump 37 was formed in opening for IC chip mounting, and opening for multilayer printed wiring board mounting, and it considered as the substrate for IC chip mounting (refer to drawing 8 (b)).
In addition, as a photo detector 38, what consists of InGaAsP was used as a light emitting device 39 using what consists of InGaAs.
[0216]
B. Production of a multilayer printed wiring board
B-1. Production of the resin film for the resin insulating layers between layers
The resin film for the resin insulating layers between layers was produced using the approach used by A-1, and the same approach.
B-2. Preparation of the resin constituent for through tube restoration
The resin constituent for through tube restoration was produced using the approach used by A-2, and the same approach.
[0217]
B-3. Manufacture of a multilayer printed wiring board
(1) Copper clad laminate which 18-micrometer copper foil 8 laminates to both sides of the insulating substrate 1 which consists of a glass epoxy resin with a thickness of 0.6mm or BT resin was used as the start ingredient (refer to drawing 9 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and

nonelectrolytic plating processing is performed, and is etched in the shape of a pattern — both sides of a substrate 1 — a conductor — the circuit 4 and the through hole 9 were formed (refer to drawing 9 R> 9 (b)).
[0218]
(2) a through hole 9 and a conductor — the conductor which washes in cold water the substrate in which the circuit 4 was formed, sprays an etching reagent (the product made from MEKKU, MEKKU dirty bond) by the spray, and includes a through hole 9 after drying — the roughening side (not shown) was formed in the front face of a circuit 4.
[0219]
(3) the following approach after preparing the resin filler indicated to the above B-2 — after preparation — less than 24 hours — the conductor in a through hole 9 and on a substrate 1 — the circuit agenesis section and a conductor — the layer of resin filler 10' was formed in the rim section of a circuit 4.
That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 10' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 9 (c)).
[0220]
(4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 10' might remain neither in the front face of a circuit 4, nor the land front face of a through hole 9, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate.
Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 10 was formed.
[0221]
thus, a through hole 9 and a conductor — the surface section of the resin filler 10 formed in the circuit agenesis section, and a conductor — the front face of a circuit 4 — flattening — carrying out — the resin filler 10 and a conductor — the insulating substrate which the side face of a circuit 4 stuck firmly through the roughening side, and the internal surface and the resin filler 10 of a through hole 9 stuck firmly through the roughening side was obtained (refer to drawing 9 (d)). this process — the front face of the resin filler layer 10, and a conductor — the front face of a circuit 4 turns into the same flat surface.
[0222]
(5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 4, and the land front face of a through hole 9 — a conductor — the roughening side (not shown) was formed in all the front faces of a circuit 4. In addition, as an etching reagent, the product made from MEKKU and MEKKU dirty bond were used.
[0223]
(6) Next, the somewhat larger resin film for the resin insulating layers between layers than the substrate produced by the above B-1 was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the resin insulating layer 2 between layers was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 10 (a)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.
[0224]
(7) Next, the opening 6 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 2 between layers by CO2 gas laser with a wavelength of 10.4 micrometers through the mask with which the through tube with a thickness of 1.2mm was formed on the resin insulating layer 2 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the through tube of a mask, and the conditions of one shot (refer to drawing 10 (b)).
[0225]
(8) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 6 for the Bahia halls by immersing the substrate in which the opening 6 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution removal of the epoxy resin particle which exists in the front face of the resin insulating layer 2 between layers.

[0226]
(9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI).
Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out roughening side processing (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 6 for the Bahia halls to be included) of the resin insulating layer 2 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.
[0227]
(10) Next, the substrate was immersed into the non-electrolytic copper plating water solution, and the non-electrolytic copper plating film 12 with a thickness of 0.6-3.0 micrometers was formed in the front face (the internal surface of the opening 6 for the Bahia halls is included) of the resin insulating layer 2 between layers (refer to drawing 10 (c)).
In addition, the used nonelectrolytic plating water solution and nonelectrolytic plating conditions are the same as that of (10) of the production process of the substrate for IC chip mounting.
[0228]
(11) The substrate in which the nonelectrolytic plating film 12 was formed was rinsed, electrolysis plating was performed after that, and the electrolytic copper plating film 13 with a thickness of 20 micrometers was formed on [whole] the nonelectrolytic plating film 12 (refer to drawing 11 (a)).
In addition, the used electrolysis plating water solution and electrolysis plating conditions are the same as that of (12) of the production process of the substrate for IC chip mounting.
[0229]
(12) Next, etching resist 3 was formed by sticking a commercial photosensitive dry film on the substrate with which the electrolytic copper plating film 13 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 11 (b)).
[0230]
(13) next, the conductor which consists of non-electrolytic copper plating film 12 and electrolytic copper plating film 13 by carrying out etching processing of an etching-resist agenesis subordinate's electrolytic copper plating film and nonelectrolytic plating film with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carrying out dissolution removal and carrying out exfoliation removal of the etching resist with a NaOH solution 5% after that -- the circuit 7 (the Bahia hall 5 is included) was formed (refer to drawing 11 (c)).
furthermore, an etching reagent (MEKKU dirty bond) -- using -- a conductor -- the roughening side (not shown) was formed in circuit 5 (the Bahia hall 7 is included) front face.
[0231]
(14) Next, the optical waveguide 18 (18a, 18b) which uses the following approaches for the position of resin insulating-layer 2 between layers front face, and has the optical-path conversion mirror 19 (19a, 19b) was formed (refer to drawing 12 (a)).
That is, beforehand, the optical waveguide (25 micrometers in width of face of 25 micrometers, thickness) of the shape of a film which consists of PMMA by which the tip formed 45-degree optical-path conversion mirror 19 in the end using the diamond saw which is 90 degrees of V types was stuck so that the side face of the other end by the side of optical-path conversion mirror agenesis and the side face of the resin insulating layer between layers might gather.
In addition, attachment of optical waveguide applies to 10 micrometers in thickness the adhesives which become an adhesion side with the resin insulating layer between layers of this optical waveguide from thermosetting resin, and was performed after sticking by pressure by making it harden at 60 degrees C for 1 hour.
Moreover, in this example, although hardened on the conditions of 60 degrees C / 1 hour, step hardening may be performed depending on the case. It is because it is hard to generate stress by optical waveguide at the time of attachment.
[0232]
(15) Next, the solder resist constituent was prepared like (19) of the production process of the substrate for IC chip mounting, further, the above-mentioned solder resist constituent was applied by the thickness of 35 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of a substrate the condition for 30 minutes at 70 degrees C, and layer 14' of a solder REJISU constituent was formed in them (refer to drawing 12 (b)).
[0233]
(16) Subsequently, opening was formed by making one side of a substrate stick the photo mask with a thickness

of 5mm with which the pattern of opening for solder bump formation (opening for connecting with the substrate for IC chip mounting) and opening for optical paths was drawn to a solder resist layer, exposing on it by the ultraviolet rays of 1000 mJ/cm2, and performing a development to it with a DMTG solution.
And further, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, a solder resist layer is stiffened, it has the opening 15 for solder bump formation, and the opening 11 (11a, 11b) for optical paths, and the solder resist layer 14 the thickness of whose is 20 micrometers was formed (refer to drawing 13 (a)).
[0234]
(17) Next, restoration of the resin constituent containing an epoxy resin, hardening processing, etc. were performed like the process of (22) of the production process of the substrate for IC chip mounting, and the resin layer 8 for optical paths was formed in opening for optical paths. Furthermore, like the process of (23) of the production process of the substrate for IC chip mounting, the nickel-plating layer and the gilding layer were formed and it considered as the solder pad 16.
[0235]
(18) Next, soldering paste was printed to the opening 15 for solder bump formation formed in the solder resist layer 14, and by carrying out a reflow at 200 degrees C, the solder bump 17 was formed in the opening 15 for solder bump formation, and it considered as the multilayer printed wiring board (refer to drawing 13 (b)).
[0236]
C. Manufacture of the device for IC mounting optical communication
First, IC chip was mounted in the substrate for IC chip mounting manufactured through the process of Above A, the resin seal was performed after that, and IC chip mounting substrate was obtained.
Next, by making a position carry out opposite arrangement and carrying out a reflow of this IC chip mounting substrate and the multilayer printed wiring board manufactured through the process of Above B to it at 200 degrees C, the solder bumps of both substrates were connected and the solder connection was formed.
[0237]
Next, it was filled up with the resin constituent for the closures between the multilayer printed wiring boards and the substrates for IC chip mounting which were connected through the solder connection, and by performing hardening processing after that, the closure resin layer was formed and it considered as the device for optical communication (refer to drawing 1).
In addition, the resin constituent containing an epoxy resin was used as a resin constituent for the closures.
Moreover, permeability was 85% and the refractive index of the formed closure resin layer was 1.60.
[0238]
(Example 2)
The resin constituent which contains olefine resin in case the resin layer for optical paths is formed in the substrate for IC chip mounting and a multilayer printed wiring board is used. The permeability at 80% In case a refractive index forms the resin layer for optical paths of 1.58 and forms a closure resin layer, the resin constituent which contains olefine resin as a resin constituent for the closures is used. The permeability at 88% Except that the refractive index formed the closure resin layer of 1.58, the device for optical communication was manufactured like the example 1.
[0239]
(Example 3)
After performing the process of (23) of the production process of the substrate for IC chip mounting of an example 1, the device for optical communication was manufactured like the example 1 except having used the following approach for the near edge linked to the multilayer printed wiring board of the resin layer for optical paths, and having arranged the micro lens in it.
That is, the resin constituent which uses a dispenser for the edge of the resin layer for optical paths, and contains an epoxy resin was dropped, and the micro lens was formed by performing hardening processing after that. In addition, the permeability is 92% and the refractive index of the micro lens formed here is 1.62.
[0240]
(Example 4)
In the example 2, after forming the resin layer for optical paths by performing the process of (23) of the production process of the substrate for IC chip mounting of an example 1, and the same process, the device for optical communication was manufactured like the example 2 except having used the following approach for the near edge linked to the multilayer printed wiring board of this resin layer for optical paths, and having arranged the micro lens in it.
That is, the resin constituent which uses a dispenser for the edge of the resin layer for optical paths, and contains an epoxy resin was dropped, and the micro lens was formed by performing hardening processing after

that. In addition, the permeability is 92% and the refractive index of the micro lens formed here is 1.62.
[0241]
(Example 5)
When using the following approach for the near edge linked to the multilayer printed wiring board of the resin layer for optical paths, arranging a micro lens in it and forming a closure resin layer in it further after performing the process of (23) of the production process of the substrate for IC chip mounting of an example 1, the device for optical communication was manufactured like the example 1 except having used the resin constituent containing acrylic resin.
That is, the resin constituent which uses a dispenser for the edge of the resin layer for optical paths, and contains an epoxy resin was dropped, and the micro lens was formed by performing hardening processing after that. In addition, the permeability is 85% and the refractive index of the micro lens formed here is 1.60.
In addition, the permeability is 85% and the refractive index of the closure resin layer formed by this example is 1.50.
[0242]
(Example 6)
After forming the resin layer for optical paths in an example 2 by performing the process of (23) of the manufacture approach of the substrate for IC chip mounting of an example 1, and the same process, When using the following approach for the near edge linked to the multilayer printed wiring board of this resin layer for optical paths, arranging a micro lens in it and forming a closure resin layer in it further, the device for optical communication was manufactured like the example 1 except having used the resin constituent containing acrylic resin.
That is, the resin constituent which uses a dispenser for the edge of the resin layer for optical paths, and contains an epoxy resin was dropped, and the micro lens was formed by performing hardening processing after that. In addition, the permeability is 92% and the refractive index of the micro lens formed here is 1.62.
In addition, the permeability is 85% and the refractive index of the closure resin layer formed by this example is 1.50.
[0243]
(Example 7)
In the process of (14) of the production process of the multilayer printed wiring board of an example 1, when forming optical waveguide, in the outermost layer of the side which formed the optical waveguide which carries out A of opening for solder bump formation, and the optical-path conversion mirror, and formed such optical waveguide, the device for optical communication was manufactured like the example 1 except having not formed a solder resist layer so that the following approach might be used and the whole resin insulating layer between layers of the outermost layer might be covered.
[0244]
The whole resin insulating layer between layers is explained about the formation approach of wrap optical waveguide. First, by carrying out spreading membrane formation of the PMMA for lower clad formation, and carrying out heat hardening of this to the position on the resin insulating layer between layers of the outermost layer, the lower clad was formed and the core layer was formed on the above-mentioned lower clad after that by carrying out spreading membrane formation of the PMMA for core formation, and carrying out heat hardening of this. Then, the resist was applied on the surface of the core layer, and the core was formed on the lower clad by forming a resist pattern with photolithography and carrying out pattern NINGU by reactive ion etching at the configuration of a core.
Then, 45-degree optical-path conversion mirror was formed in the end of this lower clad and a core by machining.
[0245]
Next, PMMA for up clad formation was applied on [whole] the resin insulating layer between layers, and the up clad was formed on [whole] the resin insulating layer between layers by carrying out heat hardening of this so that a lower clad and a core might be covered.
In addition, the above-mentioned PMMA for lower clad formation and the above-mentioned PMMA for up clad formation consist of the same presentation.
In addition, optical waveguide will be formed on [whole] the resin insulating layer between layers of the outermost layer by passing through such a process.
Then, opening for solder bump formation was formed in the above-mentioned optical waveguide by the lasing.
[0246]
(Example 8)
It considered as the resin insulating-layer top between layers of the outermost layer of the opposite side whose

substrate was pinched the side which counters the substrate for IC chip mounting in the location of the optical waveguide formed in a multilayer printed wiring board, and the device for optical communication was manufactured like the example 1 except having formed the optical path for lightwave signal transmission so that a lightwave signal could be transmitted between optical waveguide and the optical element mounted in the substrate for IC chip mounting.
In addition, the multilayer printed wiring board of a configuration of having described above was formed by passing through the process of following the (1) - (7).
[0247]
(1) — first — (1) - (8) of manufacture of the B-3. multilayer printed wiring board of an example 1 — the same - - carrying out — both sides of a substrate — a conductor — the resin insulating layer between layers which has a circuit and opening for the Bahia halls was formed. [namely,]
(2) Next, the through tube for optical paths which penetrates the resin insulating layer between a substrate and layers was formed using the drill with a diameter of 300 micrometers, and DESUMIA processing was further performed to the wall surface of the through tube for optical paths.
[0248]
(3) By next, the approach used at the process [of an example 1] of B-3 of (9) and the same approach A catalyst is given to the wall surface of the through tube for optical paths, and the front face of the resin insulating layer between layers. Furthermore, the substrate was immersed into the nonelectrolytic plating liquid used at the process [of an example 1] of B-3 of (10), and the same non-electrolytic copper plating water solution, and the thin film conductor layer (non-electrolytic copper plating film) was formed in the front face (the internal surface of opening for the Bahia halls is included) of the resin insulating layer between layers, and the wall surface of the through tube for optical paths.
[0249]
(4) Next, plating resist was formed on the above-mentioned thin film conductor layer at the position by the approach used at the process of (11) of manufacture of the substrate for A-3.IC chip mounting of an example 1, and the same approach. Furthermore, the electrolytic copper plating film was formed in the plating-resist agenesis section by the approach used at the process of (12) of A-3, and the same approach.
[0250]
(5) next, the conductor which performed removal of the thin film conductor layer under plating resist and this plating resist, and became independent by the approach used at the process of (13) of A-3, and the same approach — the circuit and the conductor layer were formed. furthermore, the thing for which oxidation reduction processing is performed — the above — a conductor — the front face of a circuit was made into the roughening side.
[0251]
(6) Next, it was filled up with the resin constituent containing an epoxy resin in the through tube for optical paths in which the conductor layer was formed using the squeegee, flattening of the surface was carried out by buffing after desiccation, and the resin layer for optical paths was further formed by performing hardening processing.
[0252]
(7) Next, the optical waveguide which carries out A of the optical-path conversion mirror to the position on the resin insulating layer between layers of the outermost layer of the opposite side whose substrate was pinched the substrate for IC chip mounting and the side which counters was formed using the same approach as the process [of an example 1] of B-3 of (14).
Then, the multilayer printed wiring board was completed by performing the process of (15) - (18) of B-3, and the same process. In addition, when forming opening for optical paths at this process, this opening for optical paths was formed so that it might be open for free passage to the through tube for optical paths formed at the process of the above (2).
[0253]
Thus, while attaching an optical fiber in an exposure from the side face of the multilayer printed wiring board of the optical waveguide which counters a photo detector about the device for IC mounting optical communication of the acquired examples 1-8 It replaces with a photo detector, a detector is attached, and an optical fiber is minded after that. A lightwave signal Delivery, When the detector detected the lightwave signal, the desired lightwave signal could be detected and the device for IC mounting optical communication manufactured by this example became clear [having the engine performance which can be enough satisfied as a device for optical communication].
[0254]
Moreover, when the guided wave loss between the light emitting device mounted in the substrate for IC chip

mounting, and this light emitting device and the optical waveguide which counters and which was formed in the multilayer printed wiring board was measured by the following approach, it is 0.3 or less dB/cm and it became clear that a lightwave signal can fully be transmitted.
In addition, measurement of guided wave loss was performed by detecting the lightwave signal which attached the power meter in the edge by the side of the photo detector of the optical path for lightwave signal transmission through the optical fiber, transmitted after that the lightwave signal whose measurement wavelength is 850nm from the optical fiber attached in optical waveguide, and was transmitted through the optical waveguide for light-receiving, and the optical path for lightwave signal transmission with a power meter while attaching the optical fiber in the edge of the optical waveguide for light-receiving.
[0255]
Furthermore, in the device for optical communication obtained in the examples 1-8, most location gaps from the design of an optical element (a photo detector and light emitting device) and optical waveguide were not seen.
[0256]
[Effect of the Invention]
Since the device for optical communication of this invention consists of a substrate for IC chip mounting with which the photo detector and the light emitting device were mounted in the position, and a multilayer printed wiring board with which optical waveguide was formed in the position as described above, its connection loss between the mounted optics is low, and excellent in connection dependability as a device for optical communication.
[0257]
Moreover, in the device for optical communication of this invention, since dust, a foreign matter, etc. which are floating the inside of air do not enter between an optical element and optical waveguide and transmission of a lightwave signal is not checked with this dust, foreign matter, etc. when the closure resin layer is formed between the substrate for IC chip mounting, and the multilayer printed wiring board, it will excel with the dependability as a device for optical communication.
Furthermore, since the duty with which this closure resin layer eases the stress generated between the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board can be achieved and it is harder coming to generate location gap of an optical element and optical waveguide when the closure resin layer is formed, it will excel with the dependability as a device for optical communication.
[0258]
By the manufacture approach of the device for optical communication of this invention, since a closure resin layer is form among both after arrange and fix the substrate for IC chip mounting, and a multilayer printed wiring board to a position, the device for optical communication with which neither float - inside of air dust nor a foreign matter enters between an optical element and optical waveguide, and transmission of a lightwave signal is not check can be manufacture suitably.
[0259]
Moreover, it is harder it coming to generate location gap of an optical element and optical waveguide in the obtained device for optical communication by being able to achieve the duty with which this closure resin layer eases the stress which originates in the difference of a coefficient of thermal expansion, and is generated between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, and forming a closure resin layer by forming a closure resin layer between the substrate for IC chip mounting, and a multilayer printed wiring board.
Therefore, by the manufacture approach of this invention, the device for optical communication which is excellent in dependability can be manufactured suitably.
[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention.
[Drawing 2] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 3] It is the sectional view showing typically 1 still more nearly another operation gestalt of the device for optical communication of this invention.
[Drawing 4] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 5] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 6] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.

[Drawing 7] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 8] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 9] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 10] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 11] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 12]
A part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention
It is the sectional view shown typically.
[Drawing 13]
A part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention
It is the sectional view shown typically.
[Drawing 14]
It is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention.
[Description of Notations]
100,200,300 Multilayer printed wiring board
101, 201, and 301 Substrate
102, 202, and 302 Resin insulating layer between layers
104, 204, and 304 a conductor — circuit
107, 207, and 307 Bahia hall
109, 209, and 309 Through hole
111 211 Opening for optical paths
114, 214, and 314 Solder resist layer
118, 218, and 318 Optical waveguide
119, 219, and 319 Optical-path conversion mirror
120, 220, the substrate for 320 IC chip mounting
121, 221, and 321 Substrate
122, 222, and 322 Resin insulating layer between layers
124, 224, and 324 a conductor — circuit
127, 227, and 327 Bahia hall
129, 229, and 329 Through hole
134, 234, and 334 Solder resist layer
137, 237, and 337 Solder connection
138, 238, and 338 Photo detector
139, 239, and 339 Light emitting device
140 IC Chip
141, 241, 341, and 351 Optical path for lightwave signal transmission
142, 242, 342, and 352 Resin layer for optical paths
145, 245, 345, and 355 Conductor layer
150, 250, and 350 Device for optical communication
160, 260, and 360 Closure resin layer

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention.
[Drawing 2] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 3] It is the sectional view showing typically 1 still more nearly another operation gestalt of the device for optical communication of this invention.
[Drawing 4] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 5] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 6] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 7] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 8] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 9] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 10] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 11] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 12]
A part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention
It is the sectional view shown typically.
[Drawing 13]
A part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention
It is the sectional view shown typically.
[Drawing 14]
It is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention.
[Description of Notations]
100,200,300 Multilayer printed wiring board
101, 201, and 301 Substrate
102, 202, and 302 Resin insulating layer between layers
104, 204, and 304 a conductor — circuit
107, 207, and 307 Bahia hall
109, 209, and 309 Through hole
111 211 Opening for optical paths
114, 214, and 314 Solder resist layer
118, 218, and 318 Optical waveguide
119, 219, and 319 Optical-path conversion mirror

120, 220, the substrate for 320 IC chip mounting
121, 221, and 321 Substrate
122, 222, and 322 Resin insulating layer between layers
124, 224, and 324 a conductor — circuit
127, 227, and 327 Bahia hall
129, 229, and 329 Through hole
134, 234, and 334 Solder resist layer
137, 237, and 337 Solder connection
138, 238, and 338 Photo detector
139, 239, and 339 Light emitting device
140 IC Chip
141, 241, 341, and 351 Optical path for lightwave signal transmission
142, 242, 342, and 352 Resin layer for optical paths
145, 245, 345, and 355 Conductor layer
150, 250, and 350 Device for optical communication
160, 260, and 360 Closure resin layer

[Translation done.]